PB85-177400

National Surface Water Survey
Western Wilderness Area Lakes
Environmental Assessment (Draft)

(U.S.) Environmental Protection Agency
Seattle, WA

Mar 85

U.S. Department of Commerce
National Technical Information Service
NTIS

PB85-177400

EPA
UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

EPA 910/9-85-125
MARCH 1985

OFFICE OF RESEARCH AND DEVELOPMENT
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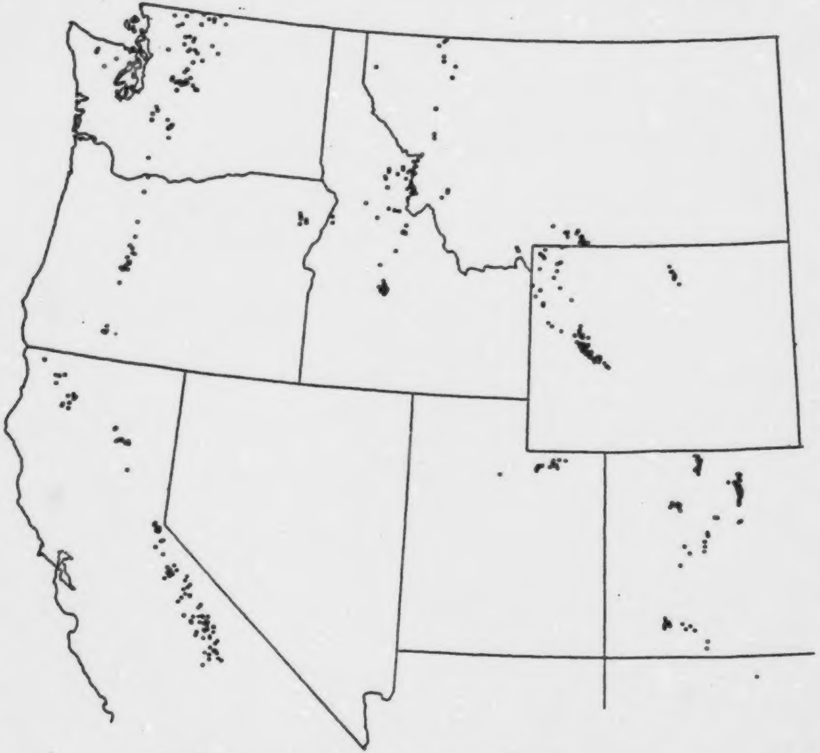
National Surface Water Survey Western Wilderness Area Lakes

ENVIRONMENTAL ASSESSMENT

DRAFT



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50272-101

REPORT DOCUMENTATION PAGE

1. REPORT NO. 910/9-85-125

2.

3. Recipient's Accession No. PB85 177400/AS

4. Title and Subtitle
National Surface Water Survey Western Wilderness Area Lakes Environmental Assessment. Draft.

5. Report Date March 1, 1985

6.

7. Author(s)

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
U.S. Environmental Protection Agency Region 10
1200 6th Avenue
Seattle, WA 98101

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
U.S. EPA Office of Research and Development
401 M Street, SW
Washington, DC 20460

13. Type of Report & Period Covered Draft

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

The U.S. Environmental Protection Agency (EPA) is proposing to sample 498 lakes in federally designated wilderness areas and national parks during the western part of the National Surface Water Survey (NSWS). The NSWS has been undertaken to provide high quality data for evaluating the nature and extent of acid deposition throughout the United States. Sampling protocols established for the national survey call for the use of helicopters to gain access to lakes for sampling. Helicopters have already been used in the eastern and midwestern parts of the survey. The U.S. Forest Service and the National Park Service will have to decide which sampling plan for wilderness areas, if any, can be approved under the Wilderness Act of 1964.

17. Document Analysis a. Descriptors

Acid Deposition
Environmental Assessment

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement:

19. Security Class (This Report)

20. Security Class (This Page)

21. No. of Pages 148

22. Price

(See ANSI-Z39.18)

See Instructions on Reverse

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

EPA 910/9-85-125

NATIONAL SURFACE WATER SURVEY
WESTERN WILDERNESS AREA LAKES
ENVIRONMENTAL ASSESSMENT

DRAFT

March 1, 1985

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SUMMARY AND CONCLUSIONS

PURPOSE AND NEED

The U.S. Environmental Protection Agency (EPA) is proposing to sample 498 lakes in federally designated wilderness areas and national parks during the western part of the National Surface Water Survey (NSWS). The NSWS has been undertaken to provide high quality data for evaluating the nature and extent of acid deposition throughout the United States. Sampling protocols established for the national survey call for the use of helicopters to gain access to lakes for sampling. Helicopters have already been used in the eastern and midwestern parts of the survey. The U.S. Forest Service (FS) and the National Park Service (NPS) will have to decide which sampling plan for wilderness areas, if any, can be approved under the Wilderness Act of 1964.

This Environmental Assessment (EA) has been prepared to evaluate the environmental consequences of alternative means of gaining access to wilderness areas to meet the objectives of the NSWS. Based on this evaluation, EPA has reviewed the possible sampling alternatives and reached a conclusion on the preferred alternative. This assessment is being provided to the FS and the NPS for their use in evaluating the alternatives, including EPA's preferred one.

As a result of its evaluation, EPA believes that wilderness area lakes should be included in the survey and that the preferred means of access is using helicopters. This conclusion is based on the following:

(1) environmental impacts of using helicopters would be transitory and would not be significant,

(2) the data collected for the survey must be of the highest quality to adequately support major policy decisions relative to a national emissions control strategy,

(3) the survey data would provide important background information that could be used to evaluate future trends of acidic deposition and lake acidification in wilderness areas not yet affected.

It is critical that a national survey of surface waters adequately represent the geographic distribution of vulnerable surface waters within each region because (1) the potential consequences of emission control policy decisions are national in scope and (2) long-range transport of pollutants can result in impacts remote from the responsible sources. As a result of the distribution of lakes in the West, sampling within the boundaries of wilderness areas is necessary to preserve the geographic representativeness of the survey.

From the standpoint of logistics, the use of helicopters is essential to meet EPA's data quality assurance objectives because (1) a large number of lakes (498) must be sampled, (2) the sampling window is very narrow (3 to 6 weeks), (3) holding times for critical chemical parameters are short (12 h maximum in some cases), and (4) safety of survey crews is of concern during a period when weather conditions can change rapidly. Sampling protocols, including the use of helicopters, have been clearly defined to minimize outside sources of variability and to ensure that the data collected are of the highest quality.

ALTERNATIVES

Four alternatives are evaluated in the EA: (1) access to all wilderness lakes to be sampled would be by helicopter, (2) access to all wilderness area lakes to be sampled would be by horseback, (3) access to the least accessible lakes would be by helicopter and to other lakes would be by horseback, and (4) no wilderness area lakes would be sampled in the study (i.e., the no action alternative).

Alternative 1 would involve using sampling protocols developed for the NSWS and already used in completing the survey in the upper midwest, the northeast, and the southeast. Helicopters would fly to each lake, land on the lake to obtain a water sample (a process taking approximately 20 min), and then proceed to the next lake or return to the field base laboratory. All samples would be analyzed and processed for shipment to an analytical laboratory for further analysis.

Alternative 2 would involve the use of horses to gain access to all lakes to be sampled. Sampling crews of four people (two samplers, a wrangler/guide, and at least one rider to transport the samples) and eight horses (four riding horses and four pack animals) would be used. Samples would be collected using a rubber boat. All chemical variables measured for Alternative 1 would also be measured for this alternative, but NSWS sampling protocols would be modified in that samples would be filtered and processed for transport at the site of collection. Samples would be transported by horseback to the nearest landing spot outside the wilderness area for further transport to the field base laboratory. Not all lakes selected for the proposed survey would be accessible under this alternative.

Alternative 3 would involve the use of horses to gain access to all lakes within wilderness areas from which samples could be transported to a helicopter landing site within seven hours. Samples would be taken from a rubber boat as in Alternative 2, but would then be transported immediately to a landing site so that they would arrive at the field base laboratory in time to be processed within a 12 h limit (i.e., samples would have to be transported to a helicopter landing site within 7 h; a transport time in the helicopter of 1 h is assumed; processing time in the field base laboratory would take 4 h). All 21 chemical variables would be measured as in Alternative 1. Helicopters would be used for gaining access to those lakes where distance or difficulties of access would prevent samples from being transported to a helicopter landing site within the required 7 h.

Alternative 4 is the no action alternative. No lakes would be sampled within wilderness area boundaries, and the western lake survey would not be conducted.

AFFECTED ENVIRONMENT

Of the 888 lakes randomly selected for sampling in the West, 425 are located in federally designated wilderness areas and 73 are located within national park areas that are not presently designated as wilderness. These wilderness areas are located in nine western states.

Wilderness areas have been established under the Wilderness Act of 1964 (Pub. L. 88-577) and related legislation as part of a National Wilderness Preservation System. These areas are to be devoted "to public purposes of recreational, scenic, scientific, educational, conservation, and historical use." Wilderness values related to preservation of wilderness character and its solitude are of great importance. Wilderness uses include backpacking, fishing, hunting, and other activities.

Biological resources include a wide variety of plant and animal life. Wildlife include large mammals such as the black bear, cougar, elk, deer, moose, mountain goat, and mountain sheep, and smaller mammals such as the bobcat, mink, and raccoon. Sport fish such as the rainbow, golden, brook, and cutthroat trout, and chinook salmon may be present in certain areas.

Endangered species that may be present in or near these areas include the woodland caribou, gray wolf, bald eagle, whooping crane, American peregrine falcon, and Kendall Warm Springs dace. Threatened species include the arctic peregrine falcon, grizzly bear, Paiute cutthroat trout, Greenback cutthroat trout, and Little Kern golden trout.

ENVIRONMENTAL CONSEQUENCES

Environmental consequences of the four alternatives are considered in terms of (1) potential environmental impacts on the existing wilderness environment and (2) potential effects on the objectives of the NSWS, which have been developed to obtain data for evaluating the impacts of present and future acidic deposition.

Environmental Impacts

Alternative 1 (Helicopter access only)

Wilderness Values. Of the major wilderness values described in Sect. 3.1.1, only the experiential and mental and moral restoration would likely be affected. Potential scientific values would remain unchanged because the proposed action would in all probability leave no physical changes to the wilderness (landing only on water) and would have only a transitory impact on wildlife due to the helicopters' noise and appearance (Sect. 4.1.3). In terms of scientific values, the proposed survey is in keeping with the spirit of the Wilderness Act in that it would use the wilderness as a barometer, or yardstick, to further understanding of the threats of acid deposition. The foremost value in wilderness management is taking those actions that preserve wilderness character, that maintain the integrity of the wilderness. To the extent that other alternatives cannot meet the timing needs and quality guidelines of the lake survey, Alternative 1 would be in keeping with the spirit and letter of the Wilderness Act.

Alternative 1 involves a one-time request for motorized access which is unlikely to serve as a precedent for granting other requests. Few, if any, future requests would meet the following unique research and administrative objectives and the methodolgical constraints of the NSWS survey: the wide-spread geographic scope of possible effects and sources, the lack of available data, potentially great ecological harm, unique monitoring and quality control procedures, and high policy and legislative priority.

Wilderness use. All recreational uses of wildernesses will be affected by the noise of the helicopters used in the proposed action. Helicopters are comparable in sound level to heavy trucks and city buses. Helicopter sounds are different in character, however, from other modes of transportation. Takeoff, landing, and flyover each has a different combination and intensity of sound. A typical wilderness might have ambient noise levels in the range of 20 to 30 dB$_A$. The loudest noise from the proposed helicopter use would be approximately 90 dB$_A$, at landing on the lake surface, 500 ft from an observer on shore. Data provided in Table 4.1-1 and Appendix A, indicate that a typical wilderness visitor at a lakeshore would first hear the sounds of a helicopter approaching from a level flyover altitude of 2000 ft. Exact data are unavailable on the intensity of this sound, but it would likely be in the vicinity of 40 dB$_A$. As the helicopter landed, the sound intensity to an observer located 500 ft from the deepest point of the lake would increase to approximately 80-90 dB$_A$. While on the water during the sampling (15-20 min), helicopter sound intensities would range from 56-66 dB if a reduced engine-idle speed could be maintained or 66-74 dB$_A$ if full engine idle speed was necessary. Takeoff sound intensities would decrease with ascent from 83 dB$_A$ to the intensities of the level flyover (40 dB$_A$ and less) as the helicopter flew from the area.

The dominant impacts of the proposed helicopter sampling associated with recreational activities would be the sight and sound of the helicopters either landing and doing the sampling or flying overhead (or both). The impact on those who make the effort to get off the formal trail system and "away" would presumably be substantially greater than to those who follow the established trails. The flightpaths of the helicopter overflights could be sensitively planned in many areas to avoid most wilderness users (Sect. 4.1.6). Recreational users may frequently be present at camp sites which are are highly clustered near lakes. The helicopters would unavoidably encounter recreational users because lakes are EPA's focus of interest. Impacts at campsites would be more disruptive than on trails, and impacts in remote, internal locations could be the greatest, despite their location. Some temporary noise intrusion due to gunshots, however, would already be present since the survey would take place during hunting season.

The most serious impact to fishing as a recreational activity would be the impact on the aesthetic dimension of the fishing experience. The proposed helicopter use involves sampling away from the shoreline at the deepest point in each lake and would have minimal impact on the fishing potential on a given day.

Hunting for some species (such as bighorn sheep or mountain goats) is essentially wilderness dependent because these species are generally only found in such areas. For other species, such as deer or elk, that are not particularly wilderness dependent, hunters may seek out wilderness settings as being most desirable for their activity. Popular big game species such as bighorn sheep and mountain goats are creatures of quite predictable habits. If they are startled by the sight and sounds of the proposed helicopter use, the fright response would be temporary. Studies show that such animals can be readily tracked (by experienced hunters) after such a disruption; presumably, the hunt could be resumed in a timely way. The most disruptive situation would occur if hunters were unable to schedule a planned trip to avoid the period during which helicopters might be operating in the area. Notification about the possibility of helicopter noise intrusion would be given to users to minimize the degree to which users are surprised by the noise and to reduce annoyance impact. In addition, it is anticipated that reduced visitation in the fall would result in fewer users being affected by the helicopters than during more popular hiking and camping seasons.

Wildlife. The only likely adverse impact on wildlife associated with the use of helicopters would be the effects of noise. Most noise effects, however, have to do with long-term exposure to relatively high levels and the consequent permanent effects on health, physiology, or behavior. In the present case, the only probable effect of one or, at most, several overflights by helicopters would be a startle or fright response. Except in the relatively unlikely event of an accident suffered by a frightened animal, such impacts would be minor and transitory.

Endangered and threatened species. Potential impacts of helicopter use on endangered and threatened species are the same as for other wildlife, but are of greater concern because populations of these species may be particularly susceptible to damage. Thus, noise from helicopters during nesting seasons of bald eagles or staging of whooping cranes, for example, could disrupt these critical reproductive activities and contribute to threats to the species' continued existence. The timing and nature of the proposed activity under this alternative, however, make significant impacts to endangered species very unlikely. Possible exceptions are where lakes are near eagle or falcon sites. Ground access would be preferable in these situations because juveniles may remain in the nest area during the postfledging period. Close coordination with wildlife officials would help minimize any problems.

Even though four endangered or threatened fish species [a dace and three trout species (Sect. 3.3)] may be found in or near wilderness areas to be sampled in the NSWS, no adverse effects would be expected except in the unlikely event of a large accidental fuel spill into a small water body containing the species (Sect. 4.1.4).

Water bodies. The major potential source of environmental impact to water bodies would be a spill or leak of fuel from the helicopters into the lakes being sampled. Leaks of hydraulic fluid and spills of other materials (e.g., pH standard solutions, freeze-gel packs) could also occur. For all but the smallest water bodies that could be encountered, no significant toxic effects would be expected, but a temporary visible sheen might result from any hydrocarbon spill or leak.

Human safety. The major safety concern with using helicopters would be an accident that resulted in death or serious injury to a member of the helicopter crew. The high altitudes and mountainous terrain associated with the proposed helicopter use involve dangerous flying conditions. Huge and difficult-to-see downdrafts or tailwinds can be caused by sharp changes in the terrain and sudden changes in weather (George Schaller, personal communications). Takeoffs and landings become much more demanding than in level terrain, low-altitude flying. In the unlikely event of an accident during the proposed NSWS survey, a chain of other impacts involving search and rescue and salvage operations would begin and could involve dangerous mountain rescues by helicopters and/or climbers; there is also the possibility of a forest fire caused by a crash. Using an estimated total flight exposure for Alternative 1 of less than 1000 h, the chance of an accident occurring during the survey would be 0.1 accident per 1000 h. During the eastern and midwestern portions of the survey no accidents occurred during the more than 1100 h of flight time that were logged.

An additional consideration in regard to human safety is the potential for a helicopter to scare a horse and injure a rider, although a vigorous program of notification can minimize this potential problem.

Alternative 2 (Horse access only)

Wilderness values. Wilderness values would be minimally affected by conducting the survey under this alternative. The long-term wilderness character might be negatively affected if survey data were not collected. Making national air quality decisions without sufficiently representative or accurate data could result in more severe, rapid, and extensive impacts of acidic deposition on given individual wilderness areas, the wilderness system in general, and/or similar areas throughout the country.

Wilderness use. This alternative would increase trail and campsite use during a time of year when wilderness visitors might reasonably expect more solitude and tranquility. The size of each pack train and number of crew members needed on each team would generally be compatible with the size of other parties visiting wildernesses. Wilderness visitors could be negatively impacted by the survey crew camping near them at lakes, but presumably no more so than by other ordinary visitors. Using horses would contribute in a minor way to the damage to trails and camping sites by trampling and feeding on surrounding vegetation, expanding the trail width, increasing the trail's depth and erosion potential, and increasing soil compaction in tethering areas. Additional physical damage could occur in places where the survey crew would need to access lakes where no trail exists. In these situations, the survey crew and its pack train would create a temporary new disturbance to the landscape; recovery rates in alpine environments would probably be slow.

Because reduced levels of visitation by general users occur during the fall period when the survey would take place (although special uses such as hunting may peak during this period), conflicts of the EPA sampling crews with other wilderness visitors for backcountry permits would be unlikely. In those wilderness areas where hunting season would be under way, a potential for conflict could exist.

Wildlife and endangered/threatened species. Under this alternative, the effects of noise on wildlife would be eliminated. Although the possibility of human contact with wildlife would increase, its nature would be no different from that already occurring and no significant impacts to wildlife would be likely. Proper coordination with local wildlife officials will ensure that survey teams are aware of potential interactions with endangered and threatened species and of the proper responses to take in the event of an encounter.

Water bodies. Because sampling of lakes would be done from an inflatable boat, no impacts on water bodies would be expected. Any chemical reagents or standards needed in the field could be left on land, rather than carried in the boat.

Human safety. This alternative involves having many people sampling high altitude lakes during the fall when weather conditions are very uncertain. Sampling teams could be isolated by early fall blizzards and be subjected to severe weather conditions. Using inflatable rafts for sampling extremely cold, alpine lakes would be dangerous. In extremely cold lakes, the human body can tolerate less than ten minutes immersion before severe hypothermia conditions interfere with judgment and physical performance. An accident in the middle of a lake could, therefore, cause serious problems.

Accidents involving horses being ridden or led through rocky, mountainous terrain are not common, but are a possibility. The use of experienced pack leaders would minimize the likelihood of any problems.

Alternative 3 (Helicopter and horse access)

Wilderness values and use. Impacts for this alternative would be intermediate between Alternatives 1 and 2, and would depend on the proportion of lakes sampled via helicopter versus horseback.

Wildlife and endangered/threatened species. This alternative would involve some minor impacts from aircraft noise, but the overall incidence would be less than for Alternative 1 because a portion of the lakes would be sampled by ground crews. Significant effects could be avoided by proper coordination with local wildlife officials.

Water bodies. Potential effects (potential spills or leaks) on water bodies under this alternative would be unlikely and would only pertain to those lakes sampled via helicopter. For those lakes to be accessed with pack horses, the probability of impact is slight.

Human safety. Potential impacts would involve both the limited possibility of death or serious injury in a helicopter accident and the possibilities of accident in sampling cold, alpine lakes from a small rubber boat and in traveling by horseback in remote areas over difficult terrain.

Alternative 4 (No action)

Wilderness values. This alternative would produce no data that could be used for identifying acidic deposition problems in wilderness areas and developing management approaches for addressing them. A potential long-term indirect impact to wilderness character could be severe if acidic deposition were to damage forest and/or aquatic ecosystems. In addition, no data would be collected for the entire western region, and control strategies could not be developed to protect these areas.

Wilderness uses. There would be no direct impacts to wilderness users under this alternative. Indirect impacts could result from the absence of data generated by the survey and no development of management strategies for protecting the areas from the effects of acidic deposition. Long-term degradation of wilderness characteristics could cause a diminished fishery resource, fewer and less vigorous game species, and loss of aesthetic quality of the natural setting.

Wildlife and endangered and threatened species. Because there will be no activities associated with the NSWS survey within wilderness areas under this alternative, there should be no direct, short-term impacts of the survey on human or ecological resources within these areas. Serious indirect impacts might result from the absence of data generated by the survey and lack of management strategies for protecting the areas from the effects of acidic deposition to the degree that such deposition could negatively affect endangered species, especially aquatic ones.

Human safety. This alternative would involve no impacts to human safety because wilderness areas would not be sampled.

Consequences for the NSWS Objectives

The NSWS lake survey is designed to provide a high quality data base for assessing the nature and extent of lakes sensitive to acidic deposition throughout the United States. The development of these data will enable EPA to respond to a Congressional mandate to assess the sensitivity of water bodies to acidic deposition and to develop emission control policies to prevent further environmental degradation. The consequences of adopting each of the four alternatives on these objectives are summarized below.

Alternative 1 (Helicopter access only)

Alternative 1 would enable EPA to meet the objectives of the NSWS. The majority of lakes selected for sampling in the high mountains of the West could be sampled during a six-week period between early September and mid-October when most lakes will be experiencing fall overturn and a representative random sample can be obtained. Sampling protocols developed and proven during 1984 sampling in the midwestern and eastern portions of the NSWS would be used. All critical chemical parameters needed for the survey could be measured. The data so obtained would be of similar quality and directly comparable to data from the other regions. In addition, there would be no difference between the sampling protocols used within and outside of wilderness areas. Logistical problems have been addressed in the 1984 fall surveys, and the experience gained in addressing these problems could be directly applied to the western survey. A preliminary evaluation indicates that Alternative 1 would cost 3.9 million dollars (Coate 1985).

Of the twenty-one chemical variables being measured, the analyses for extractable aluminum, pH, and dissolved inorganic carbon (DIC) are considered the most critical by EPA in terms of the requirements for sampling by helicopter to meet the maximum specified holding times. In the NSWS, pH will be used not only as an indicator of acidification status of lakes, but also as a quality-assurance check on a number of other measured variables. Dissolved inorganic carbon (DIC) consists of carbon dioxide, biocarbonate, and carbonate, the relative proportions of which are a function of pH. These chemical species contribute to alkalinity, which is a measure of the ability of water to absorb acidic inputs without changing pH. The DIC data collected in the NSWS will be used to quantify the contribution of inorganic carbon to alkalinity and acidity, and to calculate total anion concentration and verify pH measurements, both of which are quality-assurance measures. High levels of aluminum are considered to be a probable explanation for observed toxic effects (such as loss of fish populations) in acidified waters. A number of researchers have observed that low-pH (i.e., acidic) waters are associated with high concentrations of aluminum. Monomeric aluminum (species such as Al^{3+} and the various aluminum hydroxides) appears to be the species of concern from the standpoint of toxicity to fish, rather than total aluminum (which also includes polymeric, colloidal, extremely stable organic, and hydroxy organic complexes).

It is desirable to analyze (or, in the case of aluminum, extract) the samples as soon as possible because of possible sample degradation. DIC and pH can change with time as a result of chemical/biological processes within the sample and as a result of exchange of CO_2 with the atmosphere. Aluminum speciation (forms of the element) can change with time as polynuclear species are formed from monomeric species present at the time of collection (potentially causing an underestimate of the true concentration of monomeric aluminum); aluminum concentrations and speciation may also change as a result of changes in DIC, pH, and temperature, and as a result of adsorbance onto container surfaces. Because the NSWS samples would be isolated from the atmosphere and refrigerated, changes in aluminum speciation or concentrations might not be expected to vary as rapidly as found by other workers. However, to minimize this potential source of error, it is desirable to extract the sample as soon as possible (within 12 h).

The Quality Assurance (QA) approach has been defined, documented and implemented in the NSWS to provide the best possible data to support the objectives of the NSWS. The utility of the approach has been demonstrated in the eastern portion of the NSWS. The QA approach for the NSWS involves the following steps to ensure that adequate data are provided:

1. Standardization of sampling and analytical methods and procedures.
2. Simplification of the field operations as much as practical.
3. Thorough training of all personnel involved.
4. Use of Quality Assurance/Quality Control (QA/QC) samples and procedures to allow verification of the data.
5. Field and laboratory audits to assure that all activities are properly implemented and performed.
6. Daily QA contact with the field and laboratory activities to assure that they are properly performed and that any problems are identified and resolved.
7. Thorough evaluation of the reported data and verification of data quality.

All of these steps must be performed to assure that adequate data are provided to support the objectives of the NSWS.

Alternative 2 (Horse access only)

It is probable that the number of lakes that could be sampled under Alternative 2 would be smaller than for Alternative 1 because not all lakes would be accessible by horseback. The exact number of lakes that could not be reached is unknown at this time, but a preliminary analysis of five wilderness areas suggests that as many as 20% of the lakes would be inaccessible. Adoption of Alternative 2 would require EPA to develop a new set of sampling protocols so that samples could be filtered and processed at the site of collection. The new protocols would introduce additional sources of variation that include: (1) the possibility of sample contamination during filtration and processing at the collection site, (2) increased numbers of sampling crews (60 crews as opposed to 5 crews under Alternative 1), and (3) variable transport time to the field base laboratory because of differing distances and difficulties of access. An additional study of lakes outside wilderness areas would be needed in which both sets of protocols would be used so that the comparability of data from the two approaches could be ascertained. Even with this additional set of studies, the data would not be of as high a quality as that collected under the NSWS protocols and the following QA problems are likely to occur:

1. Data across sampling teams, field base stations, and regions might not be comparable. Thus key objectives of the NSWS might not be achieved.

2. More complicated logistics would be likely to reduce or eliminate the ability of the survey to provide comparable data of acceptable quality.

3. Increased staff requirements would mean more personnel involved in the samplin process and a higher probability that problems would ariseof data not being comparable or being of unacceptable quality.

4. Sample contamination would be much more likely to occur and to result in invalid data and loss of key survey objectives.

5. Regardless, additional QA and data management cost would be incurred just to verify that the problems did occur (i.e., additional costs to find out the data could not be used).

6. Holding times that have been established and must be met would likely be exceeded. Anyone opposed to the conclusions of the survey or subsequent regulatory actions could use the established holding times (if they were exceeded) in a court action to challenge data quality.

Logistic problems under this alternative have a high probability of limiting the attainment of the NSWS objectives. These problems include: (1) assembling and training approximately 120 people to do the lake sampling; (2) arranging for 120 experienced wranglers and riders to work with the sampling crews; (3) arranging for the use of 480 horses (4 riding horses and 4 pack horses for each crew); (4) acquiring 60 sets of sampling equipment including a number of items that are not readily available (e.g., Hydrolabs); (5) calibrating equipment such as a Hydrolab, which is difficult under the best of conditions; (6) developing operation and communication plans for coordinating the transport of samples from the lakes to helicopter landing sites; and (7) developing contingency plans for sampling under adverse weather conditions that are likely to occur in high mountain environments in transitional seasons.

In summary, adoption of Alternative 2 would present major logistical problems which in turn, and more importantly, would introduce a large and presently unquantifiable risk of jeopardizing the data quality needed for the survey. A preliminary evaluation of Alternative 2 indicates that it would cost 7.0 million dollars (Coate 1985).

Alternative 3 (Helicopter and horse access)

Alternative 3 would differ from Alternative 2 in that every effort would be made to maintain NSWS sampling protocols as closely as possible. Samples from lakes accessed via horseback would be collected from rubber boats but would then be returned to the field base laboratories within 8 h so that operational holding times could be met for critical parameters.

Quality assurance problems discussed for Alternative 2 would also be likely to occur for this alternative. Although the objectives of this alternative would be to maintain NSWS protocols as closely as possible, there would be greater uncertainties and possibilities for error than for Alternative 1. These would be result from increased numbers of samplers, greater chance of contamination during sampling from rubber boats, less control of sample conditions during transport, and greater chance of not sampling the necessary number of lakes due to adverse weather conditions. An unknown source of variation associated with subjecting the samples to constant motion during transport on the pack horses would need to be evaluated. An additional study of lakes outside wilderness areas, as described for Alternative 2, would also be needed to determine the comparability of data.

Problems of logistics would be similar to those described for Alternative 2, although fewer sampling crews and less equipment would be needed. The risk of obtaining inadequate data to meet the survey objectives is still high for this alternative because of the unknowns associated with collecting samples via horseback. A preliminary evaluation indicates that Alternative 3 would cost 5.2 million dollars (Coate 1985).

Alternative 4 (No action)

The principal consequence to NSWS objectives under Alternative 4 would be that more than half of the lakes randomly selected for sampling in the West would be omitted from the study. Although a data base could be developed, it would have little meaning because many of the most sensitive lakes in high mountain situations would not be represented. The data could not be used to make any evaluation of the situation in wilderness areas and would be of little, if any, use to wilderness area managers. Attempts to extrapolate the data to a regional level as a basis for developing and/or evaluating possible emission control strategies would be questionable. The NSWS management team has concluded that the entire survey for the western region would not be done if this alternative were selected.

CONCLUSIONS

Tables S-1 and S-2 present summary comparisons of the four alternatives considered in this EA. Table S-1 indicates that Alternative 1 and 3 have higher environmental impacts on wilderness areas than Alternatives 2 and 4, but all of these potential impacts are of a minor and transitory nature. Table S-2 clearly shows that only Alternative 1 provides the type of high-quality data for the most representative set of lakes with the minimum set of logistic problems that will permit the survey objectives to be obtained. A more detailed discussion of this comparison is given in Sect. 2.5. Based on these two parallel lines of analysis, EPA has concluded that Alternative 1 is the preferred alternative because (1) the environmental impacts are temporary and not significant and (2) it is the only alternative which will clearly result in the acquisition of the data necessary to meet the national need for evaluating the nature and extent of acidic deposition.

Table S-1. Comparison of Environmental Consequences for the Alternatives

	Alternative 1 (helicopters)	Alternative 2 (horses)	Alternative 3 (horses and helicopters)	Alternative 4 (no action)
1. Wilderness Values				
o Wilderness Character				
- Long-term preservation	+[a]	+	+	-
- Precedent setting	-	0	-	0
o Wilderness solitude	-	-	-	0
o Wilderness uses				
- Hunting and other recreation	-	-	-	0
- Scientific study	+	+	+	0
2. Biota (including E/T species)	-	-	-	0
3. Human safety (probability of serious injury or death)	-	-	-	0
4. Cumulative effects	0	0	0	0

[a] "+" indicates a positive effect; "0" indicates no effect; "-" indicates a minor negative effect.

Table S-2. Summary Comparison of Consequences to the NSWS for the Alternatives

	Alternative 1 (helicopters)	Alternative 2 (horses)	Alternative 3 (horses and helicopters)	Alternative 4 (no action)
1. Data Quality				
o Sample Design	+[a]	-	-	-
o Chemical Measurements	+	-?	-?	NA
2. Logistics	+	-	-	NA

[a] "+" indicates a positive effect; "0" indicates no effect; "-" indicates a negative effect. "?" indicates considerable uncertainty which could only be resolved by the comparability studies discussed in the text.

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GLOSSARY OF ACRONYMS

DIC	Dissolved Inorganic Carbon
DQO	Data Quality Objective
EA	Environmental Assessment
EPA	U.S. Environmental Protection Agency
FAA	Federal Aviation Administration
FS	U.S. Forest Service
MIBK	Methyl Isobutyl Ketone
NPS	U.S. National Park Service
NSWS	National Surface Water Survey
ORNL	Oak Ridge National Labortory
QA	Quality Assurance
QC	Quality Control
USGS	U.S. Geological Service

1. PURPOSE OF AND NEED FOR THE ACTION

1.1 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is proposing to sample 498 lakes in federally designated wilderness areas and national parks during the western part of the National Surface Water Survey (NSWS). The NSWS has been undertaken to provide high quality data for evaluating the nature and extent of acidic deposition throughout the United States. Sampling protocols established for the national survey call for the use of helicopters to gain access to lakes for sampling. Helicopters have already been used in the eastern and midwestern parts of the survey. The U.S. Forest Service (FS) and the National Park Service (NPS) will have to decide which sampling plan for wilderness areas, if any, can be approved under the Wilderness Act of 1964.

This Environmental Assessment (EA) has been prepared to evaluate the environmental consequences of alternative means of gaining access to wilderness areas to meet the objectives of the NSWS. Based on this assessment, EPA has reviewed the possible sampling alternatives and reached a conclusion on the preferred alternative. This EA is being provided to the FS and the NPS for their use in evaluating the alternatives, including EPA's preferred one.

1.2 PURPOSE OF THE ACTION

There is increasing evidence that acidic deposition may be occurring in western areas of the United States, including wilderness areas. The EPA is responsible for carrying out a survey to determine the extent of this problem for the entire country, and this survey will serve as a basis for policy decisions on control measures. To the degree that harmful effects due to acidic deposition may be taking place in wilderness areas, this survey should be viewed as an integral part of an over-all control strategy which will be essential to the management of the wilderness system and individual sites within it.

Concern about the effects of acidic deposition on western high mountain lakes has increased during the past several years (Yuhnke and Oppenheimer 1984). An Environmental Defense Fund study (Environmental Defense Fund 1981) emphasizes that "The most urgent need is for better information regarding the geographical distribution and rate of acidic deposition in the West." Recent studies have shown that high mountain lakes that have low buffering capacities, and are therefore sensitive to acidic deposition, are present in California (Wilson and Wood 1984; California Air Resources Board 1983), Colorado (Kling and Grant 1984; Turk and Adams 1983), Oregon (Nelson and Delwiche 1983), Washington (Welch and Spyridakis 1984), and Wyoming (Galbraith 1984; Stuart 1984). More general reviews indicate that acidic deposition occurs along the entire West Coast (Powers and Rambo 1981) from California to Washington and in the Intermountain West (Yuhnke and Oppenheimer 1984). Although there is no clear demonstration that lake acidification currently occurs in this region, most researchers agree that continued acid loading from new and existing sources is cause for concern that effects similar to those being observed in eastern North America and Scandinavia will also occur in the West. Potential new sources of acidic emissions include

(1) planned smelters directly across the border in Mexico, (2) proposed coal-fired power plants in the Rocky Mountain states, and (3) natural gas processing plants (Wyoming, Colorado, New Mexico) and fertilizer plants (Wyoming) (Yuhnke and Oppenheimer 1984).

The NSWS is a part of a national effort [mandated under the Acid Precipitation Act of 1980 (Title VII, Pub. L. 96-294)] to evaluate the extent of aquatic resources sensitive to acidic deposition and assess the environmental, social, and economic effects on these resources. The survey has been designed to provide a statistically consistent set of data that can be used to assess the number and distribution of lakes throughout the United States that are sensitive to acidic deposition. This data base could assist regulatory and land management agencies in developing long-term monitoring programs and in designing corrective measures.

The NSWS was initiated at the request of the Administrator of the EPA in October 1983 when an assessment of the effects of acidic deposition on aquatic resources indicated that extant data could not provide a quantitative basis for documenting the present chemical and biological status of aquatic resources in the United States (USEPA 1984a, Galloway et al. 1984). This review found that existing data could not be quantitatively compared because (1) different analytical methods had been used in various studies, (2) different chemical parameters were measured, (3) sampling locations were not selected at random, therefore limiting the usefulness of the data in characterizing regions, and (4) the quality of the data was highly variable. As a result of these findings, the NSWS has been rigorously designed to provide statistically comparable data which can be extrapolated to regional and national levels.

The NSWS consists of three phases: Phase I is designed to quantify the regional chemistry of lakes and streams throughout the United States, with a focus on areas now believed to contain the majority of low alkalinity waters; Phase II will quantify the biological components and temporal water chemistry variability within and among regionally representative lakes and streams, as determined in Phase I; and Phase III will initiate long-term monitoring of lakes and streams representative of a geographic region of the United States. This EA considers only the Phase I survey of western wilderness lakes for several reasons: (1) surveys of streams in all three phases will not use helicopters; (2) helicopters will not be used to gain access to wilderness areas during Phases II and III; (3) in most, if not all, cases, lakes to be sampled during Phases II and III can be selected outside of wilderness areas; and (4) no permanent equipment will be installed in wilderness areas during any phase of the study.

The primary objectives of the Phase I synoptic survey of lakes are to determine (1) the percentage (by number, area, and location) of lakes in the acidic-deposition-susceptible regions of the United States that are acidic; (2) the percentage (by number, area, and location) of low-alkalinity lakes in the acidic-deposition-susceptible regions of the United States; and (3) a selection of regionally representative lakes that can be used in Phases II and III of the NSWS (USEPA 1984a). The survey has been designed to use state-of-the-art analytical methods, some of which have been developed specifically for the NSWS. A detailed quality assurance/quality control (QA/QC) program has been established for all aspects of the survey (i.e, field sampling, field station operations, laboratory analyses, and data management). A major effort has been directed toward minimizing variability associated with field collection, handling of samples, laboratory bias in analysis, and data entry. This detailed QA/QC program responds to EPA Order 5360.1, "Policy and Program Requirements to Implement the Quality Assurance Program" (Alm 1984).

Under EPA Order 5360.1, all Agency data collection activities are to be based on a program that will ensure that the resulting data are of known quality and are suitable for the intended purpose. Data quality objectives were incorporated into the lake survey by means of the following process (Michael 1984):

1. Define lake survey objectives as commissioned by William D. Ruckleshaus, Administrator of the U.S. EPA.
2. Identify intended uses of data and primary and secondary data users, including Ruckleshaus' needs and commitments to Congress.
3. Clarify the problem through defining and setting priorities for objectives.
4. Develop overall conceptual approach.
5. Determine options and develop specific approaches to meet identified objectives.
6. Develop survey design with rationale for each procedure used.
7. Develop specific Data Quality Objectives (DQOs).
8. Develop analytical protocols and QA/QC procedures to be followed.
9. Implement the study design through a pilot study.
10. Revise/modify approach or methodology where required with the approval of senior technical staff and program manager appointees.

Specific aspects of the NSWS QA/QC program are discussed throughout the EA, as appropriate and in Sect. 2.1.4.

The EPA proposes using helicopters to gain access to the lakes for several reasons: (1) a large number of lakes must be sampled, (2) the sampling window is very narrow (3 to 6 weeks), (3) holding times for critical chemical parameters are short (12 h maximum in some cases), and (4) concern for the safety of survey crews during periods when weather conditions can change rapidly. Sampling protocols, including the use of helicopters, have been clearly defined to minimize outside sources of variability and to ensure that the data collected are of the highest quality.

The Phase I lake survey for the eastern United States was completed during the fall of 1984. Over 2000 lakes were sampled by helicopter between early September and mid December. Samples were taken to field base laboratories where they were processed and shipped immediately to analytical laboratories for final measurements. Holding times for samples were always met, and few problems were encountered in meeting the procedural objectives of the study. Sampling of the 888 western region lakes has been deferred to the fall of 1985 so that the issue of gaining access to wilderness area lakes can be resolved.

1.3 NEED FOR THE ACTION

Approximately 48% of the western lakes selected for sampling during the Phase I survey are located in federally designated wilderness areas, and an additional 73 lakes that are not so designated occur within national parks (Sect. 3.2). For purposes of this analysis, concerns associated with national parks are assumed to be similar to those for wilderness areas; thus a separate analysis is not presented. Survey lakes are concentrated in wilderness areas occurs primarily because (1) there are many federally designated wilderness areas in the west and (2) both wilderness areas and lakes potentially sensitive to acidic deposition tend to be found at high elevations. Use of aircraft, including helicopters, is generally prohibited within wilderness areas.

Wilderness areas have been established under the Wilderness Act of 1964 (Pub. L. 88-577) and related legislation, as part of a National Wilderness Preservation System. Under Sect. 2(c) of the Wilderness Act a wilderness area is described as follows:

> A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this chapter an area of underdeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

Section 2(a) of the Act states further that a wilderness

> ... shall be administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness.

Section 4(c) of the Act specifically prohibits certain uses which are inconsistent with wilderness preservation, among these being the use of motor vehicles and motorized equipment and the landing of aircraft. Section 4(c) states

> Except as specifically provided for in this chapter, and subject to existing private rights, there shall be no commercial enterprise and no permanent road within any wilderness area designated by this chapter and, except as necessary to meet minimum requirements for the administration of the area for the purpose of this chapter (including measures required in emergencies involving the health and safety of persons within the area), there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area.

Section 4(d)(1) also sets forth special provisions for permitting nonconforming wilderness uses, among them aircraft use where necessary to control fire, insects, and disease, under the discretion of the Secretary of Agriculture. Activities compatible with wilderness preservation may be carried out for the purpose of gathering information about mineral or other resources.

Wilderness areas are much more than areas for primitive recreation experiences. As stated at a recent FS workshop on air quality and acidic deposition (Deitemeyer 1984)

> Wilderness is and has always been intended to be a living museum, a place of historical and cultural research value, a multiple-use area that continues to provide clean water, wildlife habitat, grazing and mineral resources where appropriate. Every bio-physical component of Wilderness is absolutely essential to the whole. ... The hydrology, soil chemistry, meteorological effects and visibility are critical components of the Wilderness ecosystems that allow natural processes to evolve and be experienced. No one component can be altered without affecting the other components and so allow for the retention of the character of the Wilderness as required by the Wilderness Act. The loss of any one component may result in the loss of a unique gene pool, a loss of a research and discovery opportunity and possibly a future foregone."

Use of aircraft by federal agencies and others can be authorized if an administrative or cooperative activity is essential to managing a wilderness area and "cannot be reasonably achieved using primitive methods or by nonmechanical means." In determining what is reasonable, there must be evidence that "the need is based on more than efficiency, convenience, and economy [USDA undated (Sect. 2320.3)]."

Under the Prevention of Significant Deterioration (PSD) provisions of the Clean Air Act (42 USC 1857 et seq.), federal land managers of Class I areas (i.e., wilderness areas and national parks) have the responsibility to protect "air quality related values" (AQRVs) threatened by new air pollution sources or modifications to existing sources. The AQRVs include visibility, flora, fauna, soils, and water quality; effects considered might be direct and immediate or indirect and long-term, as in the case of acidic deposition. The availability of a regional data base on susceptibility of lakes to acidification (that would be developed by the NSWS) would be a valuable source of information for the FS, the NPS, and other land managers in assessing the effects of new and modified air pollution sources on wilderness areas and in fulfilling their responsibilities under the Clean Air Act.

In addition, there is some evidence wilderness areas may be affected by acidic deposition. This could have a deleterious effect on aquatic species, especially endangered ones. Given the large geographic scope of possible effects and sources, the survey will provide Federal land managers with important data on the current impact of this problem, if any. In the future, should monitoring show increasing impacts of acid deposition on non-wilderness lakes, this data will provide an essential baseline to determine if individual wilderness lakes, or classes of such lakes, are at risk, and will therefore be integral to management of these areas for acid deposition impacts.

1.4 THE SCOPING PROCESS

A scoping process was undertaken to involve affected government agencies and the public in defining issues to be addressed in the EA. The scoping process has consisted of three types of interactions. Initially, meetings were held between headquarters staff of EPA, the FS, and the NPS to discuss the concerns of the land management agencies and to define the type of analysis that would be needed. Following a meeting in Washington on November 7, 1984, EPA decided to hold a series of scoping sessions with FS staff in the five most affected FS Regions, to describe the proposed survey and solicit regional FS concerns. Meetings were held in Missoula, Montana; Ogden, Utah; Portland, Oregon; San Francisco, California; and Lakewood, Colorado, between November 26 and December 7, 1984. In addition to FS and EPA staff, representatives from the Department of the Interior and various state agencies attended some of the meetings. On December 14, 1984, a request for public comment was sent directly to interested organizations. On December 20th, a press release was sent to the Associated Press and United Press International wire services in each of the affected states. Since that time numerous stories have appeared in the press and on the radio. These stories have generated a number of comments to EPA.

As a result of comments provided by the FS, other land management agencies, environmental groups, and interested members of the public, the following major issues were identified:

1. EPA should develop an EA that addresses the entire NSWS action, not just the segment dealing with sampling western wilderness area lakes with helicopters;

2. The EA should not be a justification of a specific alternative;

3. The mandate in the Wilderness Act restricting the use of mechanized equipment, aircraft landing, and structures of any kind should be included;

4. The no action alternative should be developed as a realistic way of achieving the NSWS goal by adjusting or expanding the sample design;

5. The need for sampling protocols that require short holding times (thereby requiring the use of helicopters) should be discussed, and alternative sampling protocols should be considered;

6. Alternatives for sample collection in wilderness areas that were considered but rejected, including ground access, onsite sample preparation, not sampling in wilderness areas, not sampling time-dependent parameters, etc., should be discussed;

7. Cumulative impacts should be addressed;

8. Effects of using helicopters on endangered/threatened species and big game should be evaluated;

9. Effects of helicopters on hunting, particularly special hunts, such as those for bighorn sheep, should be addressed;

10. Modifications to the sampling schedule to times of the year when use of wilderness areas is low should be considered; and

11. Lakes of particular interest to land management agencies should be considered as possible additions to the list of lakes to be surveyed.

These concerns and issues have been taken into account in developing the four alternatives evaluated in this EA. Issue No. 1 was rejected because the decision to be made is whether or not to sample in wilderness areas using of helicopter access. Also the eastern portion of the NSWS has already been completed and no EA was required. Issue 2 has been addressed through the development of reasonable alternatives, which are considered in this EA; Issues 3, 8, 9, and 11 are all addressed in the description and evaluation of Alternative 1. Issue 4 is considered in conjunction with the evaluation of Alternative 4. Issue 5 is evaluated in Alternative 2. Issue 6 is considered in Sect. 1.5. Issue 7 is considered in the evaluation of each alternative and Issue 11 is considered under mitigation for Alternative 1.

The scoping process is the initial phase of a public involvement process that will continue during and after the period of review for this EA. This process consists of two parts, direct contacts with public interest groups and individuals during preparation of the EA, and working with the press and media during the survey to inform the public of NSWS activities at the local level. All these activities will be covered in a public involvement plan that will be distributed with the final EA and will be an important mitigation measure for alerting wilderness area users to the schedules and reasons for NSWS activities in specific areas (Sect. 4.1.6).

1.5 ALTERNATIVES AND ISSUES CONSIDERED BUT NOT ANALYZED

Several suggestions were made during the public comment period that EPA consider an alternative using access on foot, which would involve transporting the necessary equipment by backpack. A preliminary evaluation of this suggestion indicates that the amount of equipment required for sampling a lake (including a rubber boat, a Hydrolab, ice chests for preserving the samples, other sampling equipment, any camping equipment, and survival gear) would be bulky and heavy. Although it might be possible to sample a few lakes at short distances from a helicopter landing site outside a wilderness area, the difficulty of the terrain in such areas and the amount of equipment needed could limit the feasibility of such an approach. Although this alternative has not been fully evaluated in the EA, EPA believes that the consequences to survey objectives would be the same as those discussed for Alternative 2 (Sect. 4.2.7), which involves the use of horses.

Suggestions were made during the public comment period that volunteers from interested environmental groups be used to collect the samples. Use of volunteers would result in the potential for a large statistical error because of the large number of people that would be involved in collecting samples. Furthermore, liability considerations in case of accidents during the sampling restrict EPA's ability to use volunteers. For these reasons, this alternative is not evaluated further in the EA.

It was suggested that another alternative would be to reduce the number of chemical parameters measured for wilderness lakes to those that do not have critically short holding times. This alternative would reduce the need to transport the samples quickly to a laboratory for initial analysis and sample preparation. Some elements of this alternative are incorporated in Alternative 2 (Sect. 2.2). The NSWS management team feels, however, that the proposed approach would eliminate the ability to collect data on critical parameters that need to be assessed (e.g., monomeric aluminum and dissolved inorganic carbon) and, therefore, the studies of lakes in wilderness areas would be of little value (see Alternative 4, Sects. 2.4 and 4.4). For this reason, the suggested alternative is not considered further in the assessment.

A concern was raised about the effects of helicopters on grazing in wilderness areas. Grazing is allowed in wilderness areas only in situations where previous use was established before designation. Preliminary evaluation of this concern indicates that any disturbance would be negligible and would not affect inherent wilderness values. Therefore, further analysis is not deemed necessary. If helicopters are used, advance planning should prevent most conflicts with grazing animals, and pilots landing on lakes where stock are present in large numbers should be instructed to approach the lake in such a way as to avoid the animals.

Sampling in the spring, rather than the fall, has been suggested as a means of avoiding conflicts with hunters in wilderness areas. However, this would have such severe consequences to the NSWS that it was not evaluated in detail in this EA. Variability of spring lake conditions is high, depending on winter snowfall and temperatures, which in turn affect snowpack, runoff, ice thickness, and time of ice-out. Incomplete spring mixing can result in virtually no "window" between ice-out and the onset of summer stratification for individual lakes (USEPA

1984a). On the other hand, the "window" for a given subregion (e.g., the Cascades) could be very long (up to several months) because of differences in lake morphology and aspect relative to the sun, complicating planning and logistics. Also, sampling in the spring could increase the potential for disturbing wildlife during sensitive reproductive periods (e.g., nesting of raptors); in particular, sampling in the spring could conflict with this period for the federally designated as threatened/ endangered bald eagle, peregrine falcon, and whooping crane (Sect. 4.1.3).

2. ALTERNATIVES

2.1 ALTERNATIVE 1 (USE OF HELICOPTERS ONLY)

Alternatave 1 would involve the use of helicopters to sample all lakes in the survey, including the 498 lakes that occur in wilderness areas and national parks (see the map on the cover page). The helicopters would operate out of field base stations located at five regional airports (Sect. 2.4). Samples would be collected each day and returned to the field base laboratory (explained in Sect. 2.1.3) where they would be analyzed for certain physicochemical characteristics and processed for shipping to analytical laboratories. Before sampling a lake, the helicopter would circle the lake so that pictures and notes on land use and lake characteristics could be taken. The helicopter would then land on the lake, briefly cruise the center of the lake to determine the depth, and obtain a sample at the deepest part. During sampling, the helicopter engine would remain on so that position on the surface could be maintained at the sampling station and for safety reasons. The sampling process would take approximately 20 to 30 min. No permanent sampling apparatus would be left in the lake or its surroundings. Figure 2.1-1 shows the steps involved in collecting samples by helicopter.

2.1.1 Sampling Design

Lakes to be sampled in the West have been randomly selected as part of the lake selection process for the entire national survey. Alternatives 1, 2, and 3 would all involve sampling as many of these randomly selected lakes as possible.

Lakes have been selected using a stratified random sampling design as follows. The sample was regionalized to restrict the lakes to areas potentially sensitive to acidic deposition (Omernik and Powers 1983). After the regions of interest were designated (Northeast, upper Midwest, Southeast, mountainous West), subregions were delineated based on similarities in geographic and other characteristics (Omernik and Kinney 1984). For example, mountain ranges, such as the Adirondacks in the Northeast and the Cascades in the mountainous West, would become subregions.

Within subregions, existing data on lake alkalinity were used to delineate areas of probable similar alkalinity or alkalinity strata. Decisions on boundaries of alkalinity strata sometimes were supported by other information known to be associated with alkalinity. For example, in the Northeast, alkalinity is strongly associated with land use (viz., lakes in undisturbed forested areas tend to show low alkalinity while those in agricultural areas show relatively high alkalinity). Subregions and alkalinity strata for the mountainous West region are shown in Fig. 2.1-2.

Within each stratum (alkalinity class-within subregion-within region), 50 lakes were randomly selected as follows. The lakes available for selection within each stratum were identified on standard U.S. Geological Survey (USGS) quadrangles. Each was given a number to be entered into a computer. The number of lakes available for sample selection within each western subregion and alkalinity stratum is shown in Table 2.1-1. (Information to subdivide these totals by wilderness status was not available for this EA.) From this sample universe,

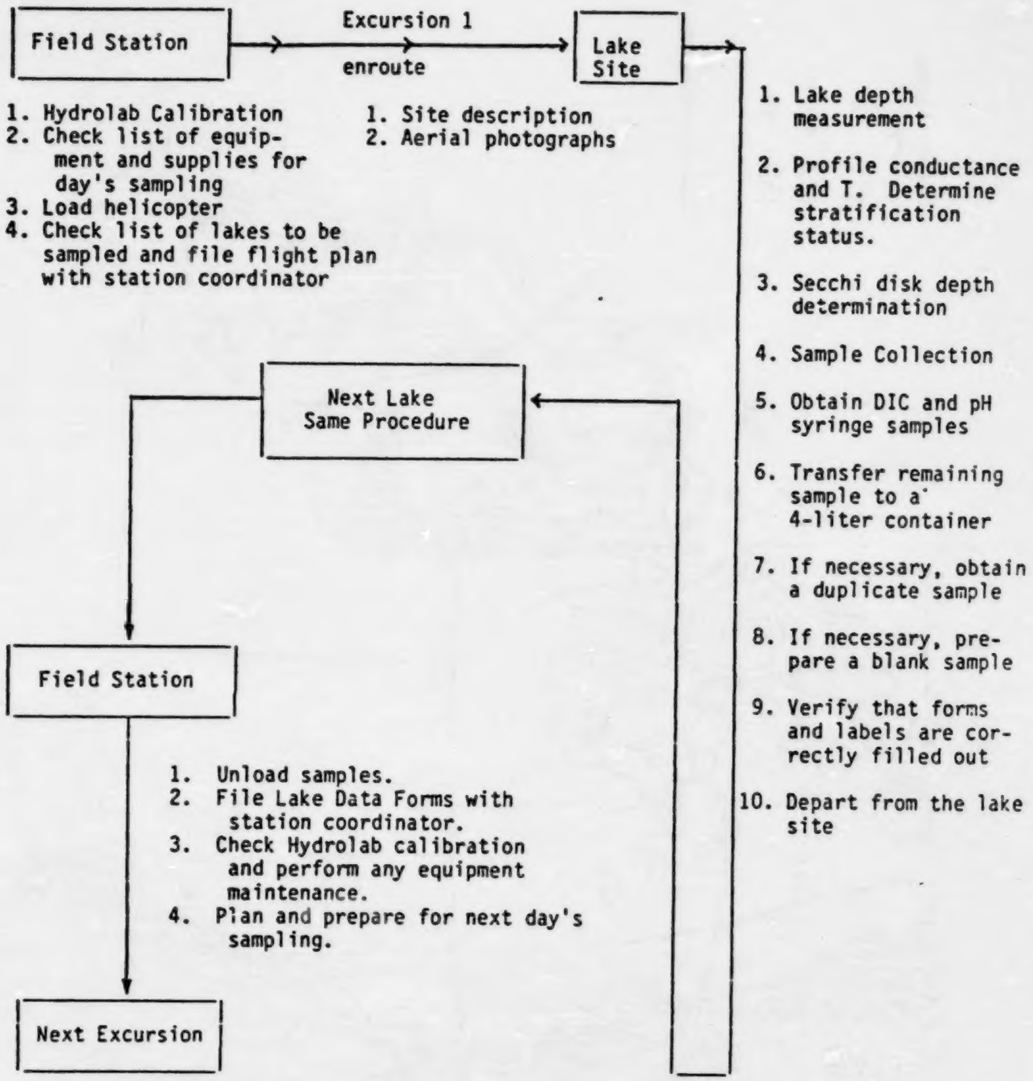
Field Station
Excursion 1
enroute
Lake Site
1. Hydrolab Calibration
2. Check list of equipment and supplies for day's sampling
3. Load helicopter
4. Check list of lakes to be sampled and file flight plan with station coordinator
1. Site description
2. Aerial photographs
1. Lake depth measurement
2. Profile conductance and T. Determine stratification status.
3. Secchi disk depth determination
4. Sample Collection
5. Obtain DIC and pH syringe samples
6. Transfer remaining sample to a 4-liter container
7. If necessary, obtain a duplicate sample
8. If necessary, prepare a blank sample
9. Verify that forms and labels are correctly filled out
10. Depart from the lake site
Next Lake Same Procedure
Field Station
1. Unload samples.
2. File Lake Data Forms with station coordinator.
3. Check Hydrolab calibration and perform any equipment maintenance.
4. Plan and prepare for next day's sampling.
Next Excursion

Fig. 2.1-1. Helicopter sampling crew activities (Source: Hillman et al. 1984).

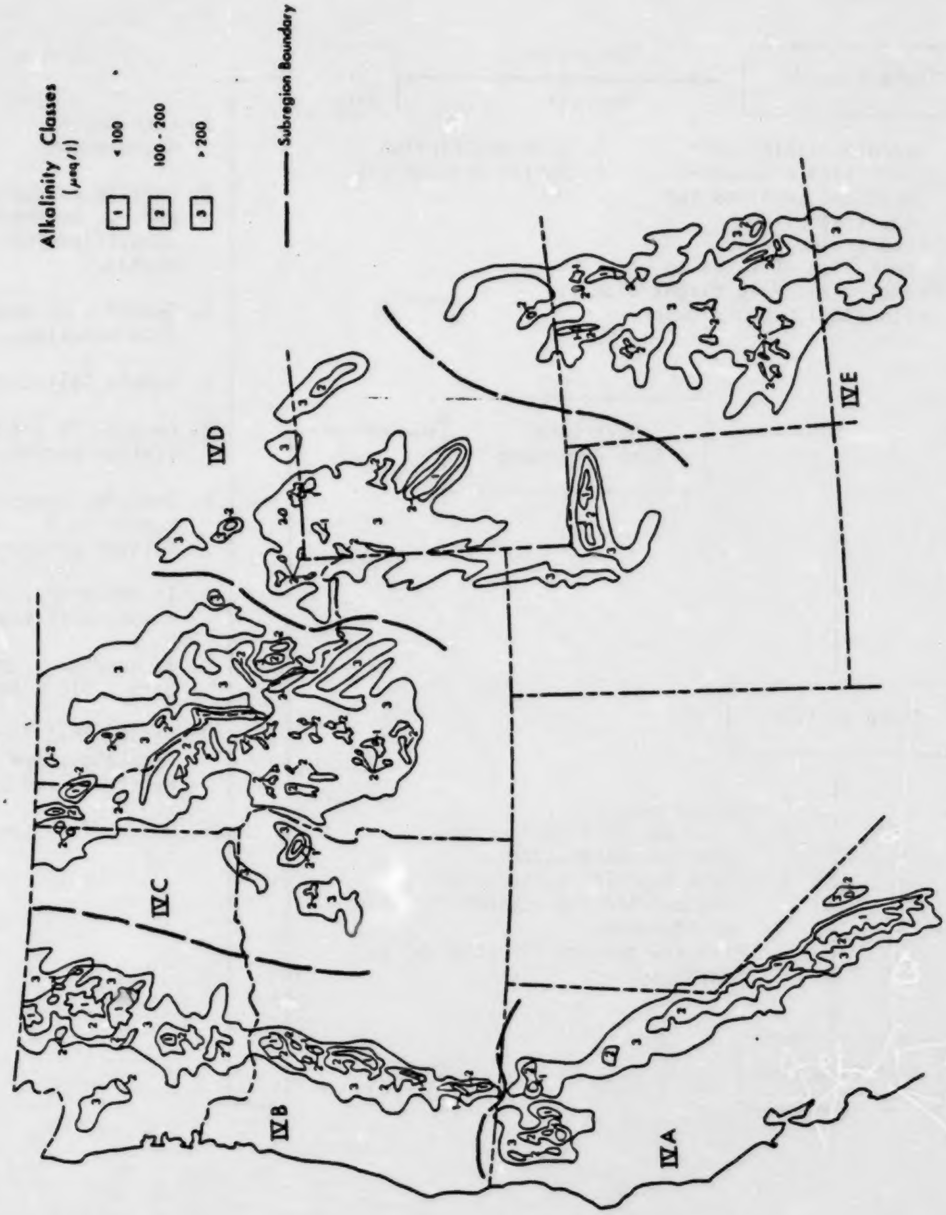
Alkalinity Classes
(μeq/l)
1 <100
2 100 - 200
3 >200
Subregion Boundary
IV A
IV B
IV C
IV D
IV E

Fig. 2.1-2. Distribution of alkalinity classes in the western region (Source: Omernick and Powers 1983).

Table 2.1-1. Total number of lakes available for sample selection in the mountainous West region by subregion and alkalinity class

Alkalinity	Subregion A	B	C	D	E	Total
1	1,885	695	343	885	150	3,958
2	538	724	675	1,024	261	3,222
3	383	781	2,317	1,061	1,784	6,326
Total	2,806	2,200	3,335	2,970	2,195	13,506

Table 2.1-2. Number of lakes randomly selected by alkalinity class and wilderness status, with lakes in national parks classified as being within wilderness areas

Alkalinity class	Status: In wilderness	Out of wilderness
1	248	54
2	151	144
3	99	192
Totals	498	390

the sample (50 lakes/stratum) was then randomly selected. In each stratum, additional lakes have been randomly selected to serve as alternates, because some selected lakes will not be suitable for sampling (e.g., lake no longer exists, is found to be too shallow, or is flowing water).

Of the lakes selected, about half are within wilderness areas, reflecting the high proportion of relatively sensitive lakes likely to occur in remote, high altitude areas. An even larger proportion are found in the lowest (most sensitive to acidification) alkalinity stratum (Table 2.1-2). The nature of the random selection process is such that, if the process were repeated from the same group of available lakes (Table 2.1-1), a similar proportion would probably fall in wilderness areas, although different individual lakes would be involved. The use of random sampling is critical to meeting survey objectives, because otherwise most of the planned statistical tests could be rendered invalid.

2.1.2 Sampling Methods

The proposed sampling method (the method used in the East in 1984) under this alternative is described in the NSWS Methods Manual (Hillman et al. 1984) and summarized in Fig. 2.1-1. In summary, lakes would be located from the air with the aid of LORAN coordinates. The shape of the lake, as seen on USGS maps, would also be used, as well as topographic features observed from the helicopter. Aerial photographs of the selected lake and its shoreline would be taken from the helicopter. In addition to photographs, sketches of each lake would be made directly on the data sheets as a further precaution to ensure that the correct lake is sampled. At that time, a decision would be made as to whether the lake would be sampled (i.e., it is not, for example, a flowing-water system or covered by standing timber). Information would then be recorded on watershed characteristics (e.g., nearby land use and disturbance). After the helicopter landed on the lake surface at approximately the deepest point, measurements of conductivity, pH, and temperature would be taken using a calibrated Hydrolab; it would then be decided whether the lake was stratified by comparing bottom and surface temperatures. Transparency of the lake water would be determined using a Secchi disk. Finally, a water sample would be taken from a depth of 1.5 m, using a Van Dorn sampler. From the sampler, 60-mL samples would be withdrawn into syringes (which would then be sealed to maintain isolation from the atmosphere and prevent de-gassing) for later determination of pH and dissolved inorganic carbon (DIC); most of the sample would be transferred into a 4-L container. Both the 4-L and syringe samples would be placed in a cooler equipped with frozen gel-packs.

2.1.3 Chemical Measurements and Analytical Procedures

The following 21 chemical variables, as well as color and turbidity, were selected as the minimum number to be measured to evaluate adequately the present status of and future effects on sensitive lakes:

acidity
alkalinity
aluminum, extractable
 (i.e., monomeric)
aluminum, total
magnesium, dissolved
manganese, dissolved
nitrate, dissolved
organic carbon, dissolved
pH

ammonium, dissolved
calcium, dissolved
chloride, dissolved
fluoride, dissolved
inorganic carbon, dissolved
iron, dissolved
phosphorus total
potassium, dissolved
silica, dissolved
sodium, dissolved
specific conductance
sulfate, dissolved

The variables and analytical methods proposed for the NSWS (and used in the East in 1984) were critically reviewed by, and developed with the concurrence of, environmental scientists and analytical chemists from a variety of U.S. and Canadian institutions, including the USGS, Illinois State Water Survey, universities, and consulting firms (USEPA 1984b,c).

The analyses for extractable aluminum, pH, and DIC (on samples representative of in-situ lake water chemistry) are considered the most critical by EPA in terms of the requirement for sampling by helicopter to meet the specified holding times (USEPA 1984d,e). According to the NSWS Methods Manual (Hillman et al. 1984), the expected range of extractable aluminum concentrations is 5 to 1000 ug/L and the required analytical detection limit is 5 ug/L; precision above 10 ug/L is to be 10% and below 10 ug/L is to be 20%. These expected values are consistent with the results of Turk (1984a), who found dissolved aluminum concentrations in three lakes of the Flat Tops Wilderness Area, Colorado, to range from 10 to 45 ug/L, and with those of Nelson and Delwich (1983), who found extractable aluminum concentrations in eight lakes in the Oregon Cascades to range from less than 1 to 56 ug/L. Expected pH values range from 3 to 8; specified precision for field measurements is ±0.1 units and for field base laboratory (described below) measurements ±0.05 units. Expected concentrations of DIC are 0.1 to 15 mg/L, the required detection limit is 0.05 mg/L, and precision at or above 0.5 mg/L is expected to be 10%.

A measure of hydrogen ion activity, pH is a variable that is often determined in water-quality investigations. It has been found experimentally that values of pH outside the near-neutral range may be toxic to a variety of aquatic species and may also affect growth, distribution, etc. Importantly, though, pH has also been related to a number of other factors, such as form and availability of nutrients and trace elements (USEPA 1976). Indirectly, then, pH is related to the ecological and chemical quality of surface waters. In the NSWS, pH would be used not only as an indicator of acidification status of lakes but also as a QA check on a number of other measured variables. For example, through a complex set of chemical equations, pH is related to alkalinity and DIC; aberrant individual values will be used by EPA investigators to identify analytical errors (Hillman 1984).

DIC consists of carbon dioxide, bicarbonate, and carbonate, the relative proportions of which are a function of pH. These chemical species contribute to alkalinity, which is a measure of the ability of water to absorb acidic inputs without changing pH (Wetzel 1975). The DIC data collected in the NSWS will be used to quantify the contribution of inorganic carbon to alkalinity and acidity and to calculate total anion concentration and verify pH measurements, both of which are QA measures (Hillman 1984). In particular, while pH and DIC can change with time as discussed below, alkalinity (which is a function of pH and DIC) will remain constant in a sample; thus, if pH and DIC are measured simultaneously and repeatedly, changes in calculated alkalinity may be attributed to analytical error and the suspect pH or DIC values "flagged."

In recent years, scientists have paid increasing attention to high levels of aluminum as a probable explanation for observed toxic effects (such as loss of fish populations) in acidified waters (e.g., Henriksen et al. 1984). A number of researchers have observed that low-pH (i.e., acidic) waters are associated with high concentrations of aluminum (Driscoll 1982; Henriksen et al. 1984; Campbell et al. 1983). Monomeric aluminum (species such as Al^{3+} and the various aluminum hydroxides) appears to be the species of concern from the standpoint of toxicity to fish, rather than total aluminum (which also includes polymeric, colloidal, extremely stable organic, and hydroxy organic complexes) (Barnes 1975, Driscoll et al. 1980).

For all three parameters discussed above, it is desirable to analyze (or, in the case of aluminum, extract) the samples as soon as possible because of their possible degradation. DIC and pH can change with time as a result of chemical/biological processes within the sample and as a result of the exchange of CO_2 with the atmosphere (Kramer 1984). Driscoll and Schafran (1984) quantified these changes by analyzing bottled samples of lake water [samples not maintained in isolation from the atmosphere or under refrigeration (C. Driscoll, Syracuse University, New York, personal communication to R. Cushman, Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee, Jan. 28, 1985)] repeatedly over 15 d; their results are shown in Fig. 2.1-3. The direction and magnitude of the changes varied among the lakes in a manner that would have been difficult to predict. In the NSWS this degradation would be minimized by keeping the samples isolated from the atmosphere and refrigerated, so degradation might not be expected to be as great a problem as that found by Driscoll and Schafran. The quantitative effect of sample degradation on pH and DIC data cannot be predicted at this time.

Aluminum speciation (forms of the element) can change with time as polynuclear species are formed from the monomeric species present at the time of collection (potentially causing an underestimation of the true concentration of monomeric aluminum) (Barnes 1975); aluminum concentrations and speciation may also change as a result of changes in DIC, pH, and temperature, and as a result of adsorbance onto container surfaces (Campbell et al. 1983, Norton and Henriksen 1983). Driscoll (1982) quantified these changes in bottled samples (as described above for pH and DIC) (Fig. 2.1-4). Seip et al. (1984) also studied the effect of storage (refrigerated; degree of isolation from the atmosphere not specified) on measured concentrations of monomeric aluminum; they found only a 6% change in two months. Because the NSWS samples would be isolated from the atmosphere and refrigerated, changes in aluminum speciation or concentrations might not be expected to vary as rapidly as was found by Driscoll. However, to minimize this potential source of error, it is desirable to extract the sample as soon as possible (specified by the NSWS protocol to be within 4 to 6 h and in practice completed within 12 h).

The NSWS approach to minimizing the holding time between sampling and analysis or extraction would be to process samples at field base laboratories on the same day the samples are collected. The field base laboratories proposed under this alternative (and used in the East in 1984) would be trailers outfitted with equipment used for sample processing and measurement of several water-quality variables (pH, DIC, turbidity, color); this equipment would include laminar-flow hoods, water deionizers, refrigerator/freezers, filtering apparatus,

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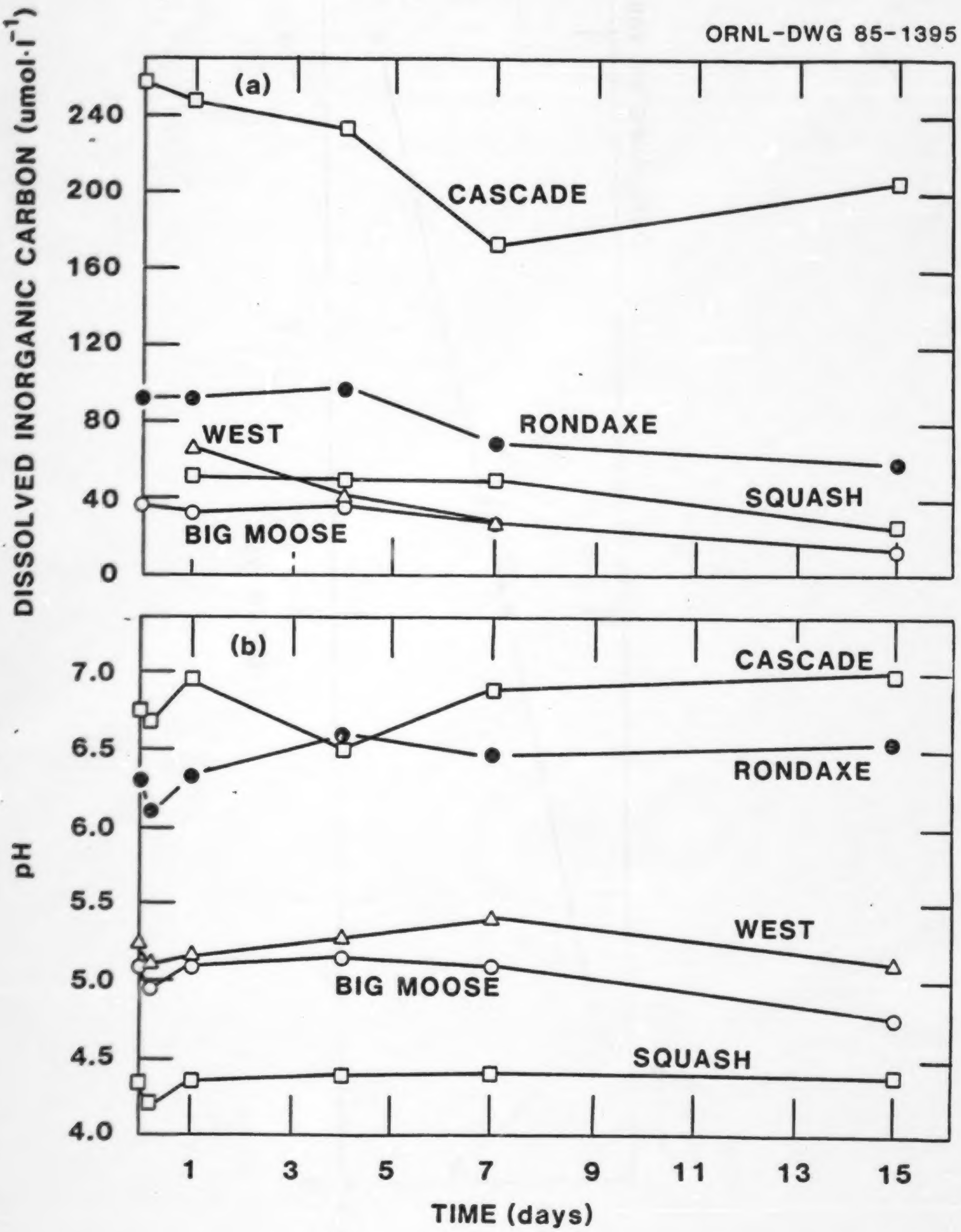

Fig. 2.1-3. Effect of storage time on (a) dissolved inorganic carbon (DIC) and (b) pH in samples of water from five Adirondack Mountain (New York) lakes (Source: Driscoll and Schafran 1984).

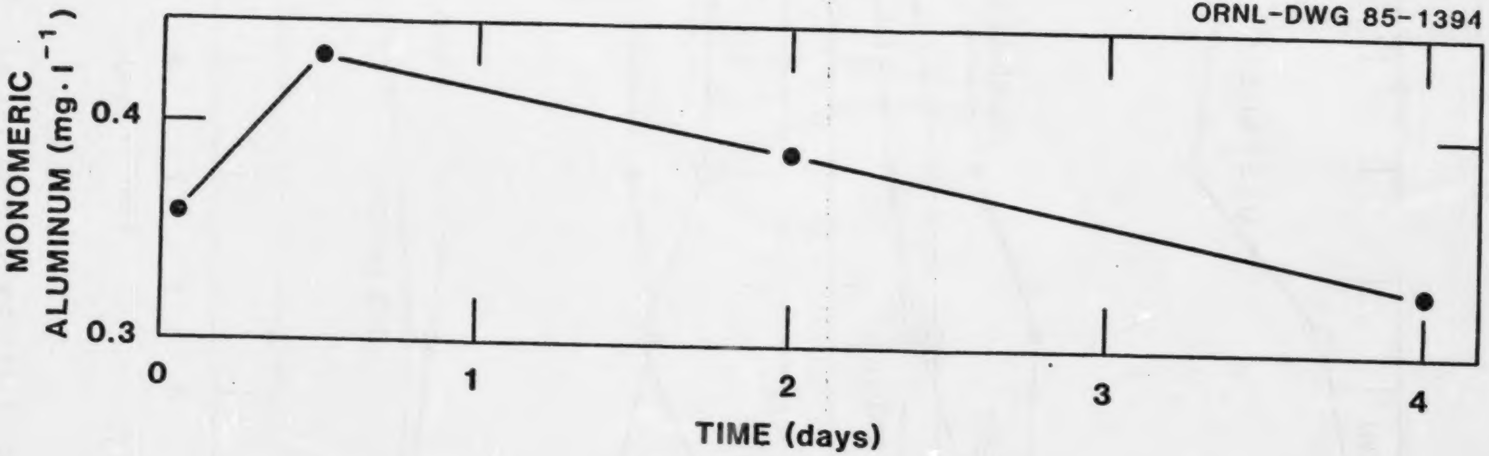

Fig. 2.1-4. Effect of storage time on monomeric aluminum in unprocessed samples of water from Big Moose Lake, Adirondack Mountains, New York (Source: Driscoll 1982).

pH meters, and carbon analyzers. The field base laboratories would each be operated by four scientists. Samples would be processed within 12 h of collection. The 4-L sample would be divided into aliquots, some of which would be filtered (0.45-um pore size). Table 2.1-3 shows the various aliquots and the analyses conducted on each of them. One filtered sample would be processed for extractable aluminum; this procedure involves chelation with 8-hydroxyquinoline acetate, pH adjustment, addition of and extraction into MIBK (methyl isobutyl ketone), and pipetting of the MIBK (and aluminum) layer into a container for eventual analysis. MIBK and 8-hydroxyquinoline are hazardous (ORNL 1981) and thus should be used only under controlled conditions as a safety measure. Aluminum chemistry in natural waters is very complex (Campbell et al. 1983), but the MIBK extraction technique selects for the monomeric aluminum species of concern (Driscoll 1984). Thus, the "extractable aluminum" technique proposed here is an operationally defined "index" to monomeric aluminum. After processing, the samples would be shipped by overnight mail to qualified commercial analytical laboratories, the remainder of the analyses to be completed within 28 d (holding times for individual parameters vary from 7 to 28 d).

The protocols used in the eastern portions of the NSWS in 1984 and preferred by the EPA for the West in 1985, for reasons of data quality and comparability, are:

Protocols for pH

(1) measured from the helicopter using a Hydrolab probe lowered in the water to a known depth. This has the advantage of being a true in-situ sample, but is expected to be of relatively poor precision because of the inherent limitations of using portable equipment in the field. This measurement will be used as a QA check on subsequent pH measurements;

(2) measured within 12 h of sampling at the field base laboratory in a sample collected (at the lake) by syringe (unexposed to the atmosphere) from a Van Dorn sampler. This is expected to be the most precise and accurate measurement for characterizing lake chemistry, but sample degradation could occur if the measurement were not made as soon as possible; and

(3) measured within seven days of sampling at the contract analytical laboratory in a sample prepared at the field base laboratory, both (a) as received, in a closed bottle and (b) after equilibration with a known gas having a constant partial pressure of carbon dioxide.

Note that measurements (1) and (2) are in samples never exposed to the atmosphere while (3b) is in a sample equilibrated with a standard gas and may be expected to vary because of gaseous exchange with the gas.

Protocols for DIC

(1) measured within 12 h of sampling at the field base laboratory in syringe sample, as in the pH measurement (2), thus providing the closest representation of in-situ lake chemistry; and

Table 2.1-3. Sample aliquots prepared by the field base laboratories (from Hillman et al. 1984).

	Aliquot						
	1 (250 mL)	2 (10 mL)	3 (250 mL)	4 (125 mL)	5 (500 mL)	6 (125 mL)	7 (125 mL)
Preservative and Description:	Filtered pH < 2 with HNO_3	MIBK Extract Store at 4°C	Filtered Store at 4°C	Filtered pH <2 with H_2SO_4 Store at 4°C	Unfiltered Store at 4°C	Unfiltered pH < 2 with H_2SO_4 Store at 4°C	Unfiltered pH < 2 with HNO_3
Parameters:	Ca	Extractable-Al	Cl^-	DOC	pH	Total P	Total Al
	Mg		F^-	$NH_4^{\ +}$	acidity		
	K		$SO_4^{\ 2-}$		alkalinity		
	Na		$NO_3^{\ -}$		conductivity		
	Mn		S_iO_2		DIC		
	Fe						

(2) measured within seven days of sampling at the contract analytical laboratory, both (a) in a closed bottle and (b) equilibrated, as with pH measurement (3b).

As with pH, the field base laboratory determination is in a sample isolated from the atmosphere, while the contract analytical laboratory determinations are in bottled samples and samples exposed to a standard gas . At both the field base laboratory and the analytical laboratory, pH and DIC must be measured at the same time to allow the DIC determinations to serve as a quality check on the pH data.

Protocols for extractable aluminum

One aliquot from the 4-L sample is filtered and extracted into MIBK at the field base laboratory to fix the aluminum, which is then analyzed at the contract analytical laboratory.

A preliminary analysis of some of the eastern survey data (J. Eilers, EPA, Corvallis, Oregon, personal communication to D. Landers, EPA, Corvallis, Oregon, Jan. 24, 1985) showed that differences of greater than 0.5 mg/L of DIC could occur between field base laboratory and analytical laboratory determinations, and differences of greater than 0.5 pH units could occur between field and field base laboratory determinations. This supports the NSWS concern over ensuring the quality of the pH and DIC data and measuring these variables as quickly and accurately as possible.

The NSWS would involve the measurement of four types of samples: routine samples are the single samples ordinarily taken from each lake; field blanks consist of Type I (deionized water) brought to the field and processed in the sampling gear, to test for possible contamination of samples; duplicate samples are second samples of lake water, to test for variability introduced by sampling and analytical procedures; and audit samples are solutions prepared to contain known concentrations of chemical constituents, to test for inaccuracies introduced during sample processing (filtering, acidification, aliquot preparation) and analysis. These various samples are important in quality control. Sampling teams would prepare field blanks and take duplicate samples daily. At least one onsite audit of samplers and field base laboratories would be conducted near the beginning of the survey. Field base laboratories would be required to process audit samples daily. Analytical laboratories would receive a variety of blind audit samples and would be required to implement calibration checks, reagent checks, etc., regularly. All personnel would receive training in these protocols, to ensure uniform procedures and to minimize errors (Sect. 2.1.5).

2.1.4 Quality Assurance

Statistical support has been an integral part of the scientific design of the NSWS and Data Quality Objectives (DQQ) were developed early in the design process to meet the requirements of the survey and the Agency. The quality assurance and quality control (QA/QC) program for the survey was then explicitly formulated to support the DQQ. The decisions that will be based on the data from the NSWS will likely influence national policy with regard to control strategies for acidic deposition. These decisions, and especially the data that support them, must be able to withstand scientific and legal challenge. Consequently, the Agency has taken the necessary steps to ensure that the data quality is impeccable and that any conclusions based on the data are statistically valid.

Approach

The QA approach that has been developed for the NSWS as a whole and that would be used in the survey of western wilderness area lakes involves the following steps to ensure that data of known quality are provided:

1. Standardization of sampling and analytical methods and procedures.
2. Simplification of the field operations as much as practical.
3. Thorough training of all personnel involved.
4. Use of QA/QC samples and procedures to allow verification of the data.
5. Field and laboratory audits to ensure that all activities are properly implemented and performed.
6. Daily QA contact with the field and laboratory activities to ensure that they are properly performed and that any problems are identified and resolved.
7. Thorough evaluation of the reported data and verification of data quality.

All of these steps must be performed to ensure that data of known quality are provided to support the objectives of the NSWS.

Standardization

The best available sampling and analytical methods for low-ionic-strength waters were selected for the NSWS. These methods were standardized (i.e, carefully detailed and documented) to ensure that all field and laboratory activities could provide accurate, precise, and comparable data. Comparability of data across sampling teams, field base stations, analytical laboratories, and especially across regions is critical in answering questions and proposing environmental controls that have national and international impacts.

Simplification

The more complicated that the logistics of a monitoring activity become, the more difficult it is to obtain comparable data of adequate quality. The NSWS lake survey is large in scope and, as a result, requires complicated logistics. Every effort has been made to simplify the logistics and reduce the number of people and steps involved in collecting, processing, and analyzing the samples.

Training

All personnel involved in the field collection and processing of samples must be qualified and thoroughly trained to ensure that all activities are performed in the same manner and result in data that can be compared across all activities. The more personnel involved in these activities, the higher the probability that problems would arise that result in data that are not comparable or are of unacceptable quality. Every effort has been made to keep the number of personnel involved in sample collection and processing to the minimum required. Additional personnel may affect the ability of the survey to provide comparable and acceptable data.

QA/QC Samples and Criteria

The QA/QC program relies on holding time and detection limit criteria and on the use of blanks, duplicates, audit samples, and QA check samples to identify QA/QC problems and to verify data quality.

The frequency of use and the application of these QA/QC samples are as follows:

Blanks. Field blanks are used to identify any contamination in the sampling and analysis process. The QA approach was designed to avoid significant contamination; maximum parameter concentrations in the blanks less than 10 percent of the lowest concentrations that might be a decision point for data interpretation. The goal is to keep contamination below 10 percent of the lowest concentration expected for each parameter in the samples to be collected. Significant effort has gone into designing the field operation to avoid sample contamination to verify that the approach used does avoid contamination. Any changes in the sampling approach could increase sample contamination. The number of blanks has been limited to one per sampling team per day. This allows the QA staff to establish an estimated range of background contamination for each sample but does not allow for background subtraction to correct for blank contamination. This approach is acceptable for the current survey design, since the sampling and analysis scheme has minimized sample contamination to a level where it should not have a significant impact on the data.

Duplicates. Field duplicates are collected at a rate of one duplicate per field base station per day. The field duplicates are used to estimate overall precision of the sampling and analytical process.

Criteria. Holding times and detection limits are important criteria for maintaining confidence in the data, especially at the low concentrations of interest to the survey. Detection limits are an analytical laboratory problem, but they are meaningless if the samples are contaminated during the sampling process. Holding times were established based on the literature or on the best scientific judgment about parameter stability in the lake samples.

2.1.5 Logistics

Under this alternative, the Phase I survey would involve the use of helicopters flying out of five base stations, tentatively located at airports in

Yakima, Washington; Missoula, Montana; Bozeman, Montana; Boulder, Colorado; and Reno, Nevada. Field base laboratories would be located at each of these base stations, and survey operations would be directed from them as well.

Two helicopters would operate out of each base station. The type of helicopter that would be used has not yet been determined, but one capable of high-altitude work would be needed in most areas. Limiting factors would be the number of samples that can be collected by each helicopter sampling crew, the number of samples each field base laboratory could handle in a day, and the number of samples the analytical laboratories could process. Figure 2.1-1 shows activities involved in sampling under this alternative.

Up to six lakes could be sampled each day by one helicopter and its crew. A preliminary review of information on the time lakes undergo fall mixing would determine the schedule and location of sampling. A sampling window from early September to mid October appears to be most likely. High-altitude lakes would be sampled as early in the project as possible, to avoid bad weather and freeze-up of the lakes. Approximately 10 to 30 min (the average was 20 min during the eastern survey) would be spent on each lake.

Each helicopter would carry three people, sampling equipment, and survival equipment in case of accidents. The crew would consist of the pilot and a sampling crew of two technicians. Lakes located at distances greater than within a 100-mile radius of the base station would be sampled from a remote station located at a closer airport, to reduce flight distances. In addition, fuel trucks, along with a helicopter mechanic, would be driven to refueling sites closer to sampling areas, to reduce the number of flights to the base station.

Survey crews and field base laboratory staff would undergo an intensive training period before the survey begins, to ensure that all personnel understand and have experience with the sampling and analytical equipment (such training was conducted for personnel involved in the eastern survey). There is a major effort to standardize sampling procedures and techniques during this training, to reduce variability due to differences in sampling and analytical operations. The number of survey crews would be kept to a minimum as well, to keep this type of variability small. Standard data sheets for use in the field and in laboratories would be used to ensure a consistency in observations made. Training in survival techniques and safety procedures for working in and from a helicopter would also be included.

Flights would be made during daylight hours only, and teams would be required to return to the field base stations two hours before sunset so that if they did not arrive as scheduled, search and rescue operations could be initiated during daylight hours. Flying in poor weather conditions would be avoided, and a 60% downtime factor (i.e., helicopters would not be able to fly because of weather, mechanical problems, etc., 60% of the time) for inclement weather and helicopter maintenance would be allocated in the planning. The field base coordinator would be responsible for making arrangements with the Federal Aviation Administration (FAA) Flight Services or other organizations to undertake search and rescue activities should the need arise. In the eastern survey this approach was an effective means of tracking daily progress of the helicopters.

2.2 ALTERNATIVE 2 (USE OF GROUND ACCESS ONLY)

Alternative 2 would involve the use of horses to gain access to as many of the 498 lakes within wilderness areas and national parks as possible. No helicopters would be used within wilderness area boundaries. Preliminary discussions with FS personnel familiar with wilderness areas in the West indicate that three categories of access situations would exist: (1) lakes which are inaccessible via horseback because no trails that could be used by horses are present; (2) lakes which are sufficiently distant from a wilderness area boundary or sufficiently difficult to reach that proposed NSWS protocols could not be met; and (3) lakes from which samples could be transported by horse to the wilderness area boundary and then by helicopter to field base laboratories quickly enough to meet NSWS protocols. A maximum transport time of eight hours from the lake to the field base laboratory would have to be met to satisfy NSWS protocols. The exact number of lakes in each category is unknown, but a preliminary evaluation of five wilderness areas (Sect. 4.2.7) suggests that significant numbers of lakes would occur in categories 1 and 2.

Because it is clear that NSWS protocols for short holding times could not be met for all lakes sampled under this alternative, the NSWS management team would require that protocols be modified for all samples collected within wilderness areas so that filtering and sample preparation would be done at the site of collection (Sect. 2.2.3). Samples would then be transported to the field base laboratory for measurements of DIC and pH of the syringe sample before shipment to the analytical laboratory.

Under this alternative, samples would be collected from a small rubber boat. In addition to the sampling crew of two people, a wrangler to manage the pack animals and one or two riders to transport samples out of the wilderness areas would be required. Helicopters would be used outside the wilderness areas to transport samples to the field base laboratory.

2.2.1 Sampling Design

Under this alternative, randomly selected lakes would be used as described for Alternative 1 (Sect. 2.1.1). Some of the selected lakes would be inaccessible by horseback because trails are not present, and at least in some strata, fewer samples could actually be collected.

2.2.2 Sampling Methods

Under this alternative, the lakes would be sampled from an inflatable boat, as was done in the Western Pilot Survey (USEPA 1984d). It would be more difficult to gather all the information that could be obtained using a helicopter, as described in Sect. 2.1 (e.g., low-elevation aerial photographs of the sampled lakes), and it would not be as easy to estimate the deepest portion of the lakes. However, some of this information might be gathered by taking aerial photographs from fixed-wing aircraft flying above 3000 ft. As in Sect. 2.1.2, a Hydrolab unit would be used to record data on temperature, pH, and conductivity; Secchi disk transparency would be measured; and a Van Dorn sampler would be used to take samples for chemical analysis.

2.2.3 Chemical Measurements and Analytical Procedures

Meeting the holding-time constraints described in Sect. 2.1.3 is probable for some selected lakes and unlikely or impossible for others (Sect. 4.2.7). In the case of lakes from which samples could not be delivered to the field base laboratory within the required time, only a change in methods or deletion of measurements for one or more chemical variables would allow retention of those lakes in the sampled population. To maximize comparability of data, under this alternative the NSWS protocols described in Sect. 2.1.3 would be changed to provide a single methodology that could be applied to all wilderness area lakes. The analyses for extractable aluminum, pH, and DIC have been cited by the EPA as being most critical in terms of sample holding time, and thus in terms of the need for helicopter access (USEPA 1984d,e). This section, therefore, will focus on alternatives to those three analyses.

The NSWS method for extracting aluminum under this alternative would be changed to consist of filtering and extracting the sample at the lake, using portable equipment (battery-powered pH meters and hand- or battery-powered pumps) and reagents, rather than in the field base laboratory.

Under this alternative, the proposed pH methods would be changed by increasing the holding time before the field base laboratory measurement. Measurement of pH at the lake, without a DIC measurement on the same sample, would not allow the QA/QC check on data quality of the pH measurement; therefore, under this alternative, it would still be important to return the syringe samples to the field base laboratory for simulataneous determination of pH and DIC. Thus, the syringe samples would be brought to the field base laboratory as soon as possible, but in most cases the holding time would exceed 12 h.

Neither Standard Methods (APHA, AWWA, and WPCF 1980) nor Methods for Chemical Analysis of Water and Wastes (USEPA 1983) gives guidance on analyzing DIC. The instrumentation for measuring DIC (a carbon analyzer that is bulky and requires a stable source of electricity) is not portable; thus, no measurements are possible until the sample is brought to the field base laboratory. The change in NSWS protocol required under this alternative, similar to that described above for pH, would consist of transporting the syringe samples to the field base laboratory as soon as possible for DIC determination, but in most cases the holding time would exceed 12 h.

In addition to the three variables discussed in this summary, it is recommended that samples for other NSWS variables (dissolved metals, for example) be either analyzed or preserved as soon as possible after sampling (USEPA 1983). Thus, under Alternative 2, the NSWS protocol would be further changed to require that all sample preparation (filtering, acidification, separation of aliquots) be done in the field using portable equipment rather than in the field base laboratory, as is currently called for. This alternative would therefore result in changes in virtually all the protocols for chemical analysis.

2.2.4 Quality Assurance

The general QA/QC approach described for Alternative 1 (Sect. 2.1.4) would be used to the extent possible. Approximately three times the number of samples (routine, blank, and duplicate) would be required for lakes reached by horseback compared with the QA/QC procedure described in Sects. 2.1.3 and 2.1.4. That is, whereas under Alternative 1 each helicopter sampling crew returns with one duplicate lake sample and one blank each day while sampling several lakes, a horseback sampling crew would return with one duplicate lake sample and blank associated with each routine lake sample. Additionally, because all sample filtration, acidification, and aliquot preparation would be done in the field under this alternative (as discussed below), the sampling crew would also be required to process a lab audit sample for each lake sampled (processed daily at the field base laboratories under Alternative 1). A field study would be needed to determine if data collected via horseback vs helicopter were different, to assess comparability with eastern survey data already collected.

2.2.5 Logistics

A pilot study conducted in western wilderness areas in the fall of 1984 (USEPA 1984f), provides a basis for estimating the logistic requirements of this alternative. Field teams for sampling lakes under Alternative 2 would be composed of a sampling crew of two, a wrangler/guide and at least one rider to transport samples. At least four pack horses would be needed to carry the sampling equipment and camping gear. In the pilot study, it took six teams of three people and two horses three weeks to sample 38 of the 50 lakes planned for sampling.

Based on the approach used in the pilot study, more than 240 people (60 field teams) and 480 horses (240 pack horses and 240 riding horses) would be needed to sample the 498 lakes in wilderness areas and national parks. Each of the field teams would need a complete set of sampling equipment, including a Hydrolab, Van Dorn sampler, pH meter, rubber boat, and many other items. In addition to sampling equipment, the field teams would need to carry camping equipment, food, survival gear, and feed and grain for the horses. More pack animals would probably be required to carry extra supplies for field teams operating in a single wilderness area for more than a few days.

Samples would be packed out each day so that a holding time of no more than 12 h could be met. The samples would need to be delivered to field base laboratories within 8 h to allow for processing time, which means that travel time from the lake to the helicopter landing site should be no more than 7 h (allowing 1 h for flight time to the field base station). Field crews would require training to ensure that sampling protocols and safety considerations (e.g., sampling from rubber boats) were met.

2.3 ALTERNATIVE 3 (COMBINED USE OF HELICOPTERS AND GROUND ACCESS)

Alternative 3 would involve the use of both helicopters and horses to gain access to lakes in wilderness areas and national parks. To determine the mix of access methods that would be needed, detailed planning between EPA and the FS or NPS would be required. Under this alternative, the objective would be to meet NSWS protocols as closely as possible. Horses would be used to gain access to lakes from which samples could be transported within 8 h to the field base laboratory. All other lakes would be sampled via helicopter.

For lakes which would be reached via helicopter, sampling crews and protocols would be identical to those described for Alternative 1 (Sect. 2.1), while for lakes reached by horse, sample collection and transportation would be similar to that described for Alternative 2 (Sect. 2.2). Sample protocols would not be modified for lakes reached by horse as in Alternative 2, but rather the samples would be transported to the field base laboratory for initial measurements and sample preparation.

2.3.1 Sampling Design

Under this alternative, randomly selected lakes would be sampled as described for the previous alternatives. Because both horses and helicopters would be used, most lakes selected could probably be sampled.

2.3.2 Sampling Methods

Under this alternative, sampling methods would be as described in Sect. 2.2.2 for those lakes that would be reached via horse and as described in Sect. 2.1.2 for those lakes that would be sampled only via helicopter. The exact mix of sampling methods would, of course, depend on the exact mix of access methods. Only those lakes from which samples could be delivered to the field base laboratory within the holding time used elsewhere in the NSWS (i.e., all samples processed within 12 h of sampling) would actually be sampled via horseback. Some information that could be gathered via helicopter but not via horseback (e.g., low-elevation aerial photographs of the sampled lakes) would subsequently not be available for some fraction of the lakes.

Because the comparability of the data collected under this alternative with that collected in the rest of the survey would be uncertain, the NSWS management team would require that 25 lakes outside wilderness areas be sampled both by helicopter access and by horse access for comparison.

2.3.3 Chemical Measurements and Analytical Procedures

Chemical measurements and analytical procedures that would be used under this alternative are described in Sect. 2.1.3.

2.3.4 Quality Assurance

The general QA/QC procedures described for Alternative 1 (Sect. 2.1.4) would be followed as closely as possible. In addition, a QA study would be needed to evaluate differences in data quality between data collected via horseback vs via helicopter to determine if the data could be compared to the eastern survey data.

2.3.5 Logistics

Detailed plans for undertaking this alternative have not been made. Logistical considerations would, however, include elements of both Alternatives 1 and 2 (Sects. 2.1.5 and 2.2.5). Field base laboratories and helicopter crews similar to those described for Alternative 1 would be used. Samples from lakes that are reached via horses would be transported to the field base laboratory each day so that short holding time measurements and sample preparation could be performed.

Helicopters would be used to meet ground crews and, in at least some cases, to pick up samples so that they could be rapidly transported to the field base laboratories. Detailed planning and communication would be necessary to coordinate ground and air operations.

2.4 ALTERNATIVE 4 (NOT SAMPLING IN WILDERNESS AREAS)

Alternative 4 (the No Action Alternative) would involve not sampling any lakes within wilderness areas. Helicopters would be used to sample lakes outside the wilderness areas in the same manner that they would be sampled in Alternative 1.

Under this alternative, the sampling universe would need to be redefined to exclude wilderness areas, and a new, randomly selected set of lakes would be sampled. Except for the exclusion of wilderness areas, the selection process would be the same as that described for Alternative 1 (Sect. 2.1.1). Data from such sampling would not be applicable, however, to wilderness areas (Sect. 4.4.6).

2.5 COMPARISON OF ALTERNATIVES

This section compares the four alternatives for the major issues addressed in Sect. 4 of the EA. Tables S-1 and S-2 in the Summary and Conclusions section summarize this comparison.

The most important potential impacts to wilderness values are considered in terms of effects on wilderness character, solitude, and use. Long-term preservation of wilderness character would best be promoted by Alternative 1 because high-quality data on all wilderness areas would be collected and could be used in developing management strategies that would best protect these areas from the effects of acidic deposition. Alternatives 2 and 3 would also promote preservation of wilderness character, but the data base would probably be less complete, the quality of the data could well be lower, and management policies would be less firmly based. Adoption of Alternative 4 would mean that no survey data would be collected for either the wilderness areas or the whole western region.

Alternative 1 involves a one-time request for motorized access which is unlikely to serve as a precedent for granting other requests. Few, if any, future requests would meet the following unique research and administrative objectives and the methodolgical constraints of the NSWS survey: the wide-spread geographic scope of possible effects and sources, the lack of available data, potentially great ecological harm, unique monitoring and quality control procedures, and high policy and legislative priority.

Alternative 1 would have the greatest likelihood of disrupting wilderness solitude because the presence of aircraft would not be in keeping with this wilderness value. Alternative 3 would have a lower impact because fewer flights would take place within wilderness areas. Alternative 2 would have some effect on solitude because approximately 240 people and 480 horses would spend several weeks in wilderness areas during the survey. Alternative 4 would have no effect on wilderness solitude because no sampling would occur within the boundaries.

None of the alternatives considered is expected to have major impacts on hunters. Under Alternatives 1 and 3, the presence of helicopters in big game areas would present the most probable chance of disturbance. Any disturbance that occurred would most likely affect only individual or small groups of animals and then only by temporarily startling them. Alternative 2 would increase the chance of encounters with hunters and game because more people would be in the wilderness areas, but there is low probability that any major disturbance would occur.

None of the alternatives would be expected to create anything but minor impacts on plants and animals in the wilderness areas. Chemical spills, fires, or direct contact with species are equally apt to occur under all the alternatives, except 4.

Alternatives 1, 2, and 3 all involve safety considerations. Historical data on helicopter accidents indicate that there is a chance of about 12 accidents per 100,000 flight hours for the types of flying most closely associated with lake sampling. No estimates of fatal or serious injury accidents are available for using horses, but it is assumed that the rate would be somewhat lower. Because the use of horses would involve a greater number of people who would be working under possible extreme conditions of weather and topography, it is believed that human safety considerations for Alternatives 2 and 3 are similar to those for Alternative 1.

The four alternatives differ considerably in terms of consequences to survey objectives. As discussed above, the survey has been designed to collect the highest quality information possible on sensitivity of lakes to acidic deposition so that a national assessment can be made of where the most sensitive receptors are and what emission control strategies should be evaluated to prevent further environmental degradation. Adoption of Alternative 1 would mean that the survey objectives would be met; the data would be of known quality, would be comparable to data gathered for the other regions of the country, and would be available for most of the lakes selected for sampling.

Alternative 2 would generate data that would be of uncertain quality and would be more difficult to compare to data collected for other regions. The risk of contamination of samples while they are being processed in the field is an important concern. In addition, the numbers of people involved in sampling will be much greater and the chance of introducing variations in sampling technique and, therefore potential error, is greatly increased. Problems with the use and calibration of 60 Hydrolabs and pH meters in the field could also introduce a substantial amount of error. It is likely that fewer lakes could be sampled under this alternative, and the data base would, therefore, be less complete than for Alternative 1.

Alternative 3 could have similar problems in terms of data quality to Alternative 2, but contamination problems would be less by not processing the samples in the field. The completeness of the data set for Alternative 3 should be comparable to that for Alternative 1 unless weather would limit the use of horses as it did in the western pilot study, but uncertainties about data quality would still be high.

Alternative 4 would provide no data for wilderness areas so that the NSWS data base would be of little use in resource management. In addition, if wilderness area data could not be obtained, there would be considerable question about the value of the national survey because a large proportion of the most sensitive lakes would not have been sampled. The NSWS management team would not conduct the survey in the West if this alternative were selected.

The four alternatives differ markedly in terms of logistical considerations. The use of helicopters for the survey was highly successful during the eastern and midwestern portions of the NSWS. Use of horses under Alternative 2 would involve training and equipping a large number of sampling crews (60 teams). There is considerable doubt that sufficient sampling equipment (e.g., Hydrolabs and Van Dorn samplers) would be available. Adoption of this Alternative would probably result in delaying the survey at least one year so that equipment could be obtained. Such a delay would mean that data would not be available on schedule for the national assessment of acidic deposition mandated by Congress for 1987. In addition, there is little flexibility under this alternative to deal with adverse weather conditions as were experienced during the western pilot study. Alternative 3 presents somewhat smaller logistical problems because fewer people would be involved in sampling via horseback and because there could be greater flexibility if trails were blocked by snowstorms, assuming lakes could then be sampled via helicopter. Neither Alternatives 2 nor 3 would reduce the use of helicopters to any great extent because they would be needed for sampling outside the wilderness areas and for transporting samples to the field base laboratories. Both alternatives would therefore result in significantly greater costs because the use of horses and extra sampling crews would be in addition to the costs required for using only helicopters for all lakes.

The comparison of alternatives indicates that adoption of the EPA proposed alternative to use helicopters to sample lakes in wilderness areas would involve only temporary disruption of wilderness values, would have limited and at least partially mitigatable impacts on hunting, and would possibly have no greater chance of fatal or serious injury accidents than other alternatives considered. No irretrievable or irreversible commitment of resources would occur. The temporary and largely mitigatable impacts are not considered to be "significant impacts to the "human environment" under the National Environmental Policy Act and are offset by the long-term advantages of obtaining high quality data on sensitivity of lakes to acidic deposition. The data obtained would be of value in providing (1) a meaningful framework for making national and regional assessments and for developing strategies to control emission sources, and (2) a data base useful for evaluating threats to long-term goals of protecting wilderness areas in the West. Therefore, EPA considers Alternative 1 to be the preferred alternative.

3. AFFECTED ENVIRONMENT

3.1 WILDERNESS VALUES, USES, AND PROTECTION REQUIREMENTS

Because compatibility with wilderness values is a primary management concern of the FS and other land managers responsible for wilderness areas (e.g., NPS, Fish and Wildlife Service, and Bureau of Land Management) in evaluating effects of alternatives in this analysis, the following section discusses the values, uses, and protection requirements associated with these areas. The FS wilderness requirements are emphasized because the large majority of the affected wilderness areas are under their jurisdiction. It is assumed that other land management agencies have similar requirements and concerns.

3.1.1 Wilderness Values

In their efforts to preserve wilderness in this country, its early proponents, as well as contemporary ones, have established three general, consistent wilderness themes, or values (Hendee et al. 1978). While wilderness is certainly slightly different in meaning to each individual, these recurring values strike a common ground and offer a background understanding for management.

Experiential. The experience of wilderness, per se, is a focus of many of the important works by American philosophers and naturalists. These writings (as well as poetry, paintings, and photographs) emphasize nature appreciation, education, freedom, solitude, and simplicity as well as spiritual, aesthetic, and mystical dimensions of the wilderness experience (Hendee et al. 1978). Authors such as Muir, Emerson, and Thoreau and naturalists such as Bob Marshall, Aldo Leopold, Wallace Stegner, and Sigurd Olson are frequently mentioned in this respect.

Mental and Moral Restoration. While there may be different kinds as well as levels of psychological responses to wilderness, it long has had a recognized value as a location for renewal of mind and spirit. This rejuvenation is more than might occur from mere withdrawal or escape from urban pressures. What makes the wilderness experience unique is the opportunity it affords for contemplation and self-insight. There is a dominance of the natural, a relative absence of civilized resources for coping with nature, and a relative absence of demands on ones behavior that are artificially generated or human imposed (Kaplan and Talbot 1983). The tranquility, peace, and silence to be found in the wilderness are necessary to create a state in which contemplation is possible, and contemplation may be necessary for the achievement and maintenance of the sense of integration and wholeness with a larger universe.

Scientific. Because of its generally undisturbed setting, wilderness offers an outstanding yardstick for measuring changes in the rest of the developed world. As a source for studying the interactions of organisms, wilderness areas are generally large enough to offer ecological insights unattainable elsewhere. George Perkins Marsh, Leopold, Muir, and Marshall each identified the unique laboratory that wilderness is. Wilderness areas also serve as laboratories for behavioral scientists concerned with how individuals relate to one another, how they cope in the face of stress and challenge, and how behavior is modified in natural environments (Hendee et al. 1978).

3.1.2 Wilderness Uses

Discussion of the utility of wilderness makes the assumption that wilderness must have uses. To those who do not see the wilderness world anthropocentrically, the concept of wilderness as a resource in and of itself makes such a discussion as absurd as discussing the use of happiness (Godfrey-Smith 1979). Many wilderness proponents, both historic and contemporary, believe that wilderness is an end in itself -- that it is an idea as well as a place having geography, topography, and geological structure; that its plant and animal life and the action of its streams, lakes, skies, and climate are sufficient to place it and its processes on each of our own mental maps of the universe (Ulph 1982). Consistent with this perspective, Sect. 4(a) of the Wilderness Act established the primary purpose, or use, of the wilderness areas as being the preservation of their wilderness character, a purpose supplemental to the purposes of the national parks, forests, and wildlife refuges.

Having said this, it is also evident that the human benefit of using wilderness is an implicit part of the Wilderness Act itself, and federal resources have been allocated to serve such purposes for years. The FS recreation manual (USDA undated) for managing wilderness areas states that the Forest Service

> is to administer wilderness for such other purposes for which it may have been established as also to preserve its wilderness character, or wilderness resource. It is to be devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use. (2320.2)

Wilderness uses range from (1) wilderness-dependent uses (e.g., some spectacular hiking and camping opportunities in areas of remarkable solitude; scientific observation; some fishing and hunting in pristine environments; and spiritual rejuvenation) to (2) wilderness-associated uses (e.g., short hiking, picnicking, and camping opportunities; fishing; hunting; and observation of nature and scenery) to (3) wilderness-independent uses (e.g., mining, grazing of livestock, and fishing for stocked fish).

3.1.3 Wilderness Protection

The Nature of Managing Wilderness. Wilderness protection means wilderness management, an apparent contradiction in terms because management suggests control and manipulation. Roderick Nash (1978) characterizes the situation well:

> The only wilderness true to the etymological roots of the word is that which man does not influence in any way whatsoever. The more man learns about wilderness, the more he visits it, maps it, writes about it -- the less wild it becomes. ...
>
> The implications of this for wilderness management are not hard to understand. When a society, usually acting through a government agency, designates a wilderness, it cannot be wilderness in the most complete and traditional sense. Management of any kind is a further compromise of a region's wildness. Even maps, trails, and signs are a

> civilizing influence -- steps toward ordering the environment in man's interest, toward lessening the amount of the unknown. The association of rangers, wardens, and search-and-rescue teams with a given area obviously detracts from its wildness. More subtle, but equally meaningful in this regard, are sophisticated management techniques. The notion of carrying capacity, use permits, and quotas, regulations on behavior, prescribed fire, and fire control gradually erode the "wild" from "wilderness." It is virtually lost when recreation demand makes it necessary to secure permits a year in advance and, at the peril of arrest and fine, to maintain a rigid back-country travel itinerary so other parties, following a day behind, have places to camp. When these requirements exist..., then wilderness is transformed into an open-air motel complete with registration and checkout times.
>
> The intellectual dilemma posed by a managed wilderness is compounded by the fact that, in the last analysis, wilderness is a state of mind. Like beauty, it is defined by human perception. This can mean that, for some individuals, regulations for management will not be a distracting presence. But for others, just the knowledge that they visit an area by the grace of, and under conditions established by, civilization is devastating to a wilderness experience. It is ironic that the success of management in protecting the wilderness experience declines in proportion to its effectiveness. In the sense discussed here, the best managed wildernesses are the least wild.

The real irony, then, is that only by deliberately managing wilderness to minimize man's influence can we, through democratic processes, have any land preserved as what we call "wilderness."

There are two philosophical poles regarding wilderness management (Hendee et al. 1978). The first, an anthropocentric position, is grounded in the notion that providing for man's "use and enjoyment" (Wilderness Act, Sect. 2) of the wilderness should have precedence over other values. The opposing view, a biocentric position, places its emphasis on the maintenance of the natural systems at the expense of recreational and other human uses if necessary. Because all wilderness values depend on the wilderness's naturalness, this position is generally favored (with considerable latitude) under recent wilderness management by the FS. Hendee et al. (1978) summarize that wilderness management is

> ... essentially the management of human use and influence to preserve naturalness and solitude.... Managers should not mold nature to suit people. Rather, they should manage human use and influence so that natural processes are not altered. Managers should do only what is necessary to meet wilderness objectives, and use only the minimum tools, force, and regulation required to achieve those objectives.

The FS manual on recreation management in wilderness areas (USDA undated) states the following (Sect. 2320):

> Management of land as wilderness must be to ensure that, in every case, wilderness values are dominant, above compromise, and enduring. Management postures must be consistent over time and space, legally and administratively unimpeachable, and totally within the concept and philosophy of the intent of retaining an enduring resource of wilderness unimpaired for present and future use and enjoyment as wilderness.

As FS policy, the manual further states (Sect. 2320.3)

> Each wilderness will be managed and all resources will be administered to promote, and perpetuate, its wilderness character and values including, but not limited to, its values for scientific study, solitude, physical and mental challenge and stimulation, inspiration, spiritual refreshment, and primitive recreation opportunities.

Biological Research. The NSWS survey falls clearly within the scope of the desired use of wilderness areas as scientific study areas. The status of baseline data collection in wilderness areas is "woefully inadequate" according to Jerry F. Franklin, Principal Plant Ecologist, U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Corvallis, Oregon (Franklin 1978). He states that in most areas it is missing, and that where work has been done, it is generally not part of a comprehensive plan. He states that

> Documentation is poor. Most work is focused on "sores" which are immediate management problem areas; such sites obviously have high priority but perpetuate a tendency to lose perspective on monitoring and baseline data needs over the wilderness as a whole.

Similar concerns have also been voiced by Drabelle (1984).

System or System to Protect a System. One argument raised during scoping of this EA was that because some of the designated lakes to be sampled are not in wilderness areas currently perceived as being threatened by acidic deposition, the use of helicopters should not be justified because the Wilderness Act gives administrative authority to the FS to allow exceptions such as the helicopters only when the wilderness character of a given wilderness is threatened. The following brief discussion of the relevant portion of the Wilderness Act underscores this point (The Wilderness Society 1984):

> The Wilderness Act, in Sect. 4(c), specified that management activities which could have negative impacts on wilderness should only be undertaken "...as necessary to meet minimum requirements for the administration of the area for the purpose of this Act...." The fundamental guiding principle for administrative activities should be whether, given the conditions specific to that site, the action is necessary to protect physical and biological resources or enhance wilderness attributes of naturalness and solitude.... Motorized access or equipment should only be used in emergency situations where necessary to protect visitor health or safety or the wilderness resource.

In other words, it has been argued that the Wilderness Act allows aircraft landings only when necessary for the protection of a particular wilderness, not when the landings are necessary for the protection of the wilderness system as a whole. This argument is not supported by the regulations of the Department of Agriculture, which provides to the Chief, Forest Service, broad discretion to "prescribe conditions under which ... aircraft ... may be used, transported, or installed by the Forest Service and its agents and by other Federal, State, or county agencies or their agents, to meet the minimum requirements for authorized activities to protect and administer the Wilderness and its resources."

Wilderness Dependency. To ensure optimum use of wilderness resources, the FS has adopted a policy of making decisions on conflicting uses based on the principle of dependency, the favoring of uses which are most dependent on primeval wilderness conditions (Hendee et al. 1978). Deciding which uses are most wilderness-dependent can be difficult where a specific activity may not generally be wilderness- dependent but a particular style or form in which it is pursued may be. Hunting for wilderness-dependent game is a clear case, but hunting for only wilderness-associated game -- although in a natural setting away from roads and other signs of civilization -- is an issue that is less clear. Anglers often cite the desire to fish in remote, difficult-to-reach lakes where one is unlikely to meet others as a reason for seeking wilderness opportunities. Elsewhere in this document (Sects. 2.1.1, 2.2.1, 2.3.1, 2.4, and 4.4.6) the wilderness dependency of the proposed action and the alternatives are discussed. The administrative basis for proposing to conduct studies such as the NSWS within wilderness areas resides in Sect. 2(c) and Sect. 4(b) of the Wilderness Act and in the FS recreation manual (USDA undated, Sect. 2323.9).

Authorization for Aircraft Use. Under Sect. 4(c) of the Wilderness Act, FS policy (USDA, undated) states that aircraft (Sect. 2320.3)

> may be authorized for use by other Federal agencies, officers, employees, agencies or agents of State and county governments when necessary to meet minimum requirements for protection and administration of the area to meet the purposes of the act, for bona fide emergencies involving the health and safety of persons within the area. The use of equipment, structures, or activities listed above may be approved also: (1) [When] either an administrative or a cooperative activity essential to the management of the wilderness cannot reasonably be accomplished with primitive methods or by nonmechanical means. In determination of what is reasonable, there must be a showing that the need is based upon more than efficiency, convenience, and economy....

In the same document, the FS states that in respect to the use of aircraft and other mechanical equipment (Sect. 2326),

> To the extent feasible, the management goal shall be to exclude the sight, sound, and other tangible evidence of motorized equipment and mechanical transport.

There are no specific prohibitions of overflight of wilderness by aircraft. The FAA has posted advisory notations (having no legal status) on all section charts, establishing a 3000-ft limit above terrain over wilderness. While the advisory notations are generally followed, penetration of the wilderness airspace does occur frequently by military aircraft and, occasionally, by hunters searching for game (Sect. 2326).

Exceptions to the regulations excluding motorized equipment and/or mechanical transportation in wilderness areas can be permitted only if the situation meets at least one of the following conditions (Sect. 2326.11):

a. It is obvious that the situation involves an inescapable urgency and temporary need for speed beyond that available by primitive means....[e.g., fire suppression, health and safety, law enforcement]

b. A delivery or application problem exists which cannot reasonably be met with the use of primitive methods....[e.g., delivery of supplies or material to construct or maintain improvements necessary for management of the area for the purposes of the act...]

c. An activity essential for administering the wilderness is confined by limitations of time, season, primitive manual skills, or other restriction which makes the job impossible by primitive means....[e.g., maintenance of trails and other improvements, construction of trails and other improvements, geodetic control]

d. A necessary and continuing program was established before the unit was incorporated into the National Wilderness Preservation System on the basis of using motorized equipment, and its continued use is essential to continuation of the program.

3.2 POTENTIALLY AFFECTED WILDERNESS AREAS

As proposed, Phase I of the NSWS would sample lakes located in 70 federally designated wilderness areas and in 10 national parks. State maps indicating the locations of wilderness areas and national parks which have lakes that would be included in the proposed survey are shown in Figs. 3.2-1 through 3.2-8. The number of lakes that would be sampled in each area is shown in parentheses.

Approximately 48% (425) of the 888 lakes selected for sampling would occur in wilderness areas or national parks. An additional 73 lakes which are not designated as wilderness areas but are located in national parks would also be sampled. Table 3.2-1 shows the number of lakes within and outside of wilderness areas and national parks for each state. A complete listing of the lakes being sampled is provided in Appendix A. The boundaries of many western wilderness areas have been affected by wilderness legislation passed by the 98th Congress in the fall of 1984. As these boundary changes are finalized, the estimates of lakes within or outside wilderness areas and parks may change slightly. The present list of lakes in Appendix A has been verified with the assistance of regional FS staff using the most current information available.

ORNL-DWG 85-1315

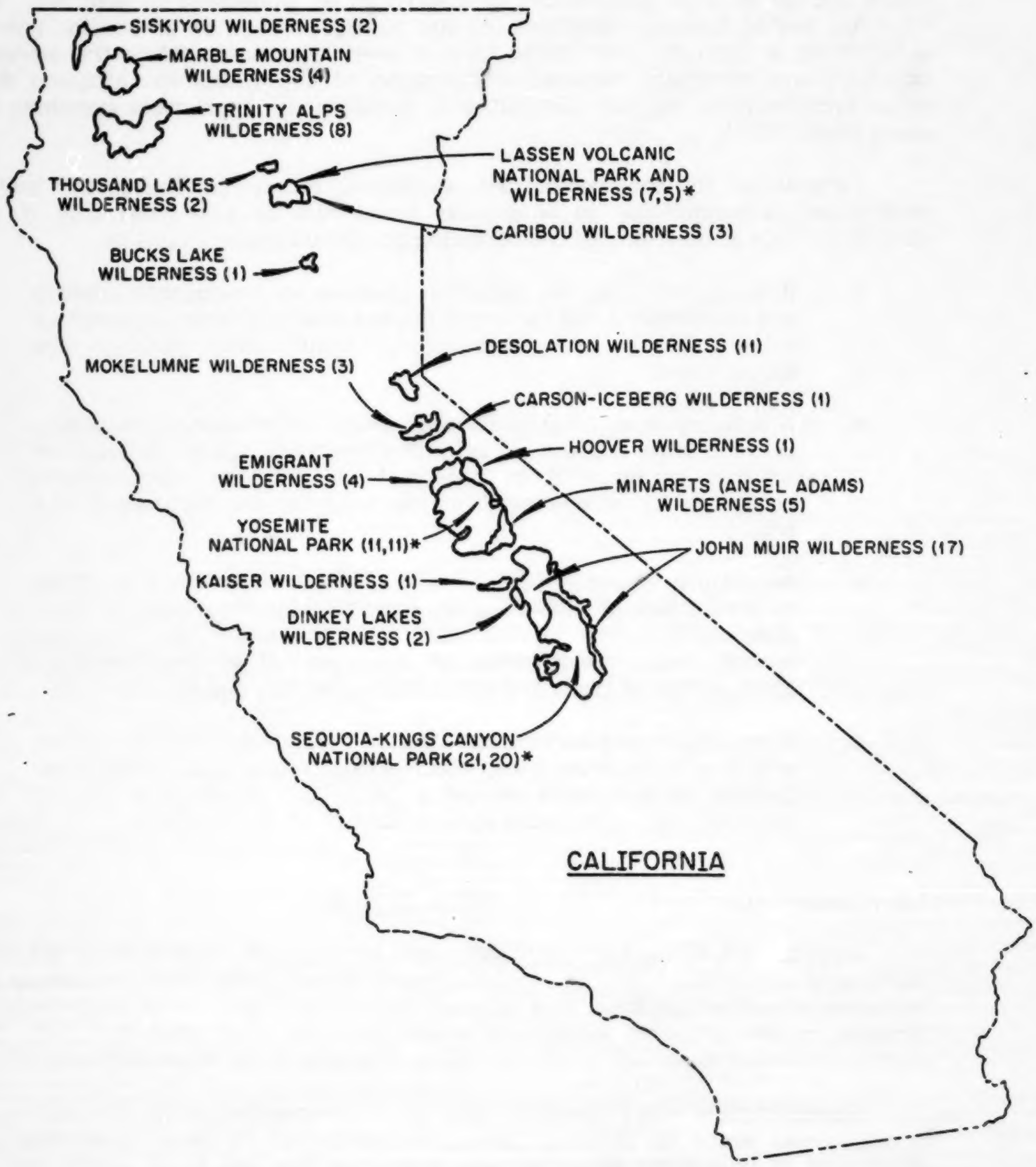
SISKIYOU WILDERNESS (2)
MARBLE MOUNTAIN WILDERNESS (4)
TRINITY ALPS WILDERNESS (8)
LASSEN VOLCANIC NATIONAL PARK AND WILDERNESS (7,5)*
THOUSAND LAKES WILDERNESS (2)
CARIBOU WILDERNESS (3)
BUCKS LAKE WILDERNESS (1)
DESOLATION WILDERNESS (11)
MOKELUMNE WILDERNESS (3)
CARSON-ICEBERG WILDERNESS (1)
HOOVER WILDERNESS (1)
EMIGRANT WILDERNESS (4)
MINARETS (ANSEL ADAMS) WILDERNESS (5)
YOSEMITE NATIONAL PARK (11,11)*
JOHN MUIR WILDERNESS (17)
KAISER WILDERNESS (1)
DINKEY LAKES WILDERNESS (2)
SEQUOIA-KINGS CANYON NATIONAL PARK (21,20)*
CALIFORNIA

Fig. 3.2-1. Wilderness areas and national parks in California with lakes proposed for sampling in the NSWS (number in parentheses indicates the number of lakes in each area or park).

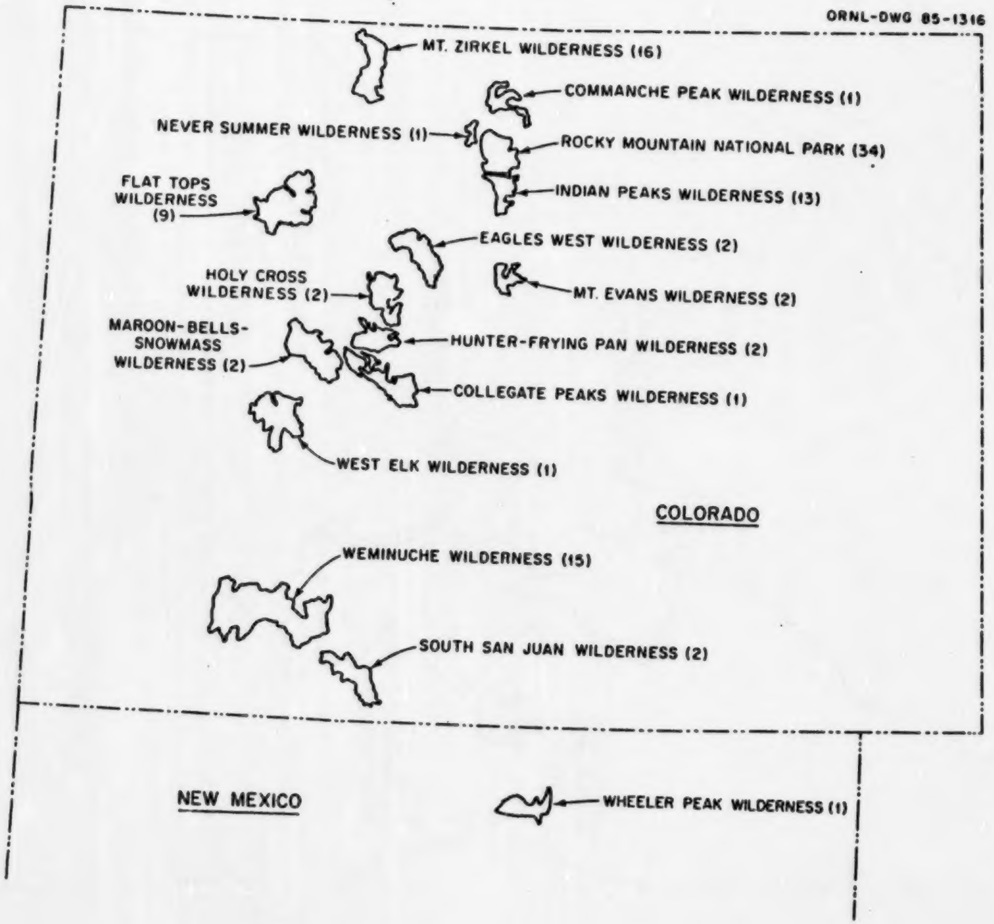
ORNL-DWG 85-1316
MT. ZIRKEL WILDERNESS (16)
COMMANCHE PEAK WILDERNESS (1)
NEVER SUMMER WILDERNESS (1)
ROCKY MOUNTAIN NATIONAL PARK (34)
FLAT TOPS WILDERNESS (9)
INDIAN PEAKS WILDERNESS (13)
EAGLES WEST WILDERNESS (2)
HOLY CROSS WILDERNESS (2)
MT. EVANS WILDERNESS (2)
MAROON-BELLS-SNOWMASS WILDERNESS (2)
HUNTER-FRYING PAN WILDERNESS (2)
COLLEGATE PEAKS WILDERNESS (1)
WEST ELK WILDERNESS (1)
COLORADO
WEMINUCHE WILDERNESS (15)
SOUTH SAN JUAN WILDERNESS (2)
NEW MEXICO
WHEELER PEAK WILDERNESS (1)

Fig. 3.2-2. Wilderness areas and national parks in Colorado and New Mexico with lakes proposed for sampling in the NSWS (number in parentheses indicates the number of lakes in each area or park).

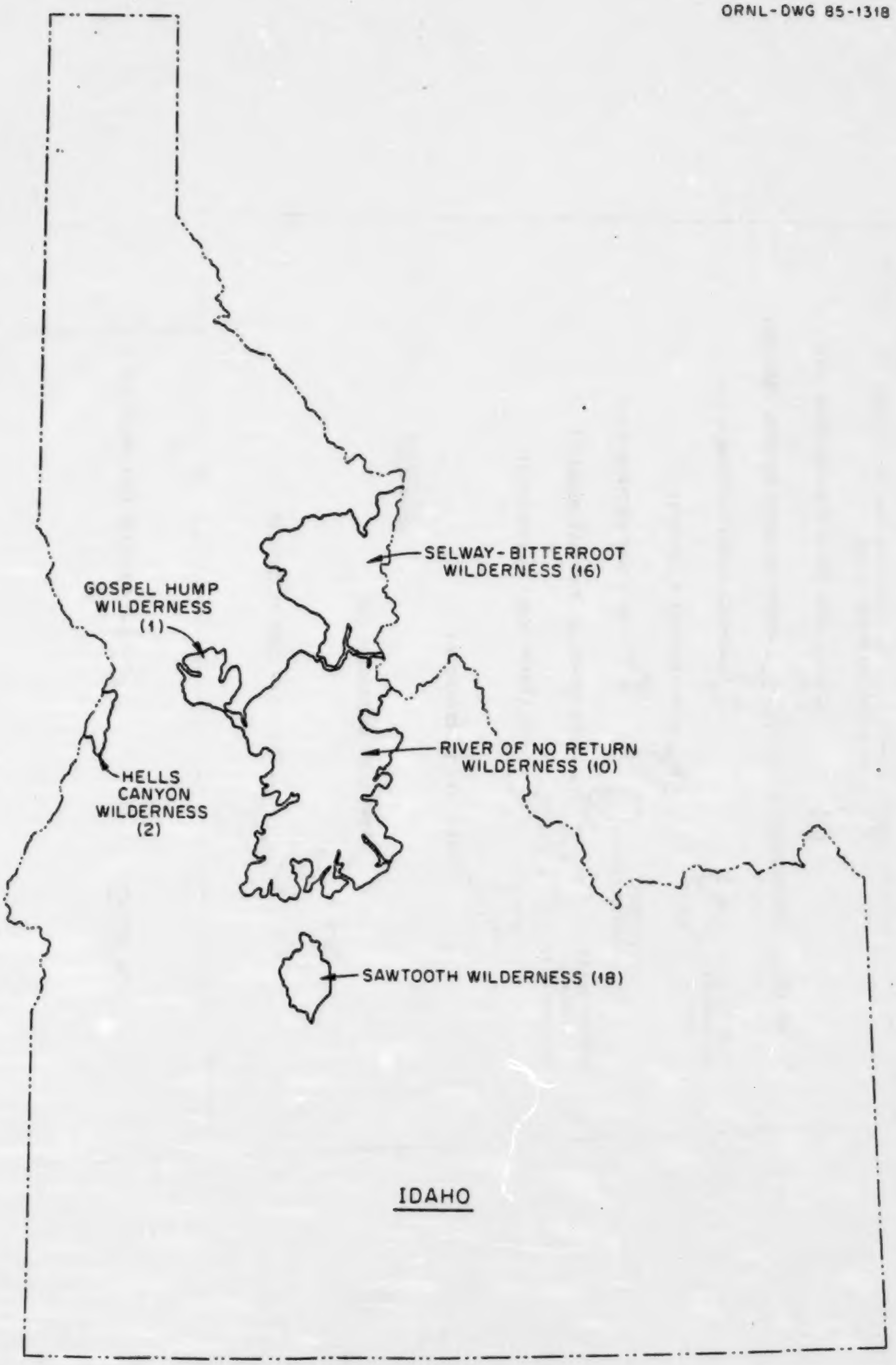
ORNL-DWG 85-1318
SELWAY-BITTERROOT WILDERNESS (16)
GOSPEL HUMP WILDERNESS (1)
RIVER OF NO RETURN WILDERNESS (10)
HELLS CANYON WILDERNESS (2)
SAWTOOTH WILDERNESS (18)
IDAHO

Fig. 3.2-3. Wilderness areas and national parks in Idaho with lakes proposed for sampling in the NSWS (number in parentheses indicates the number of lakes in each area or park).

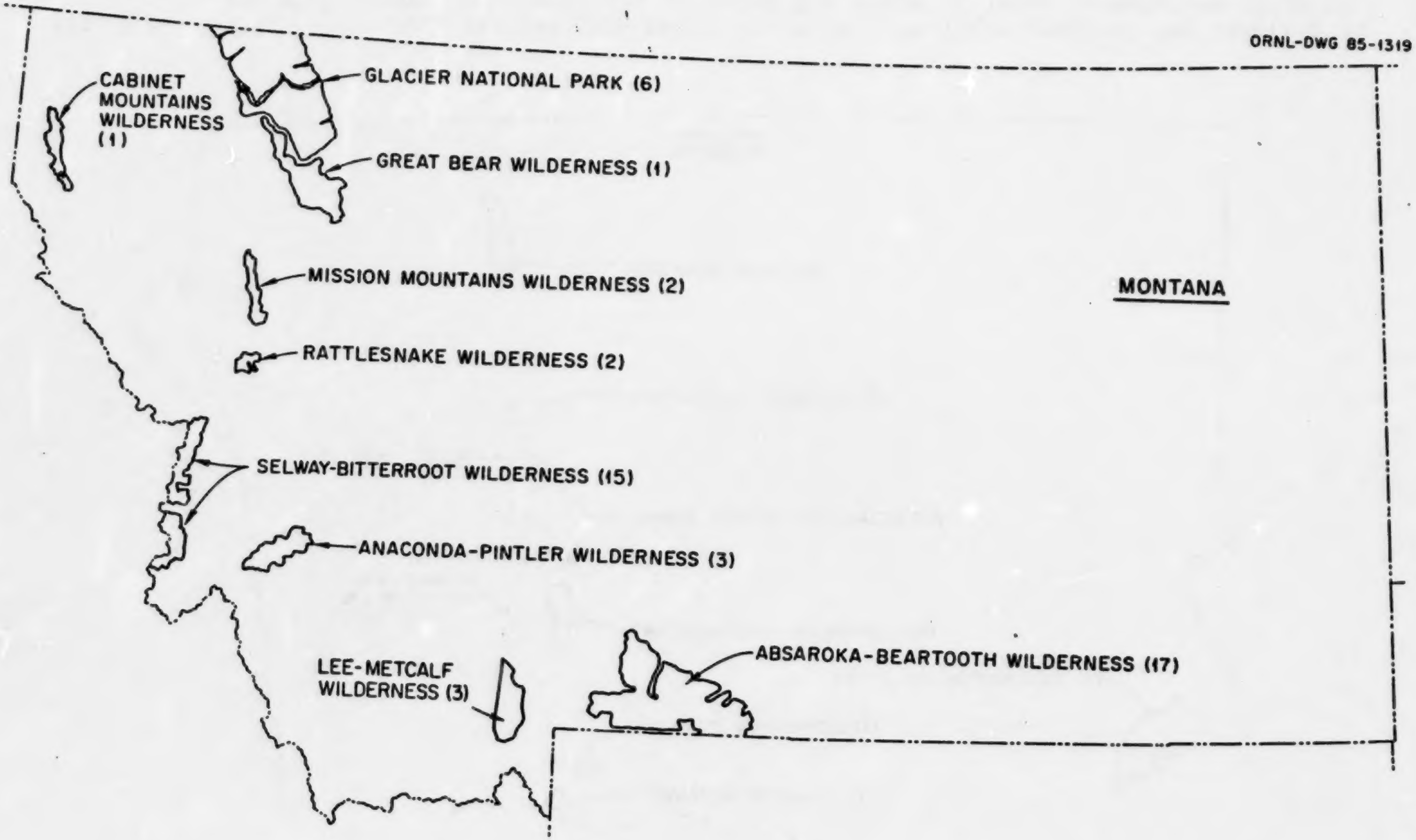
ORNL-DWG 85-1319
CABINET MOUNTAINS WILDERNESS (1)
GLACIER NATIONAL PARK (6)
GREAT BEAR WILDERNESS (1)
MISSION MOUNTAINS WILDERNESS (2)
MONTANA
RATTLESNAKE WILDERNESS (2)
SELWAY-BITTERROOT WILDERNESS (15)
ANACONDA-PINTLER WILDERNESS (3)
ABSAROKA-BEARTOOTH WILDERNESS (17)
LEE-METCALF WILDERNESS (3)

Fig. 3.2-4. Wilderness areas and national parks in Montana with lakes proposed for sampling in the NSWS (number in parentheses indicates the number of lakes in each area or park).

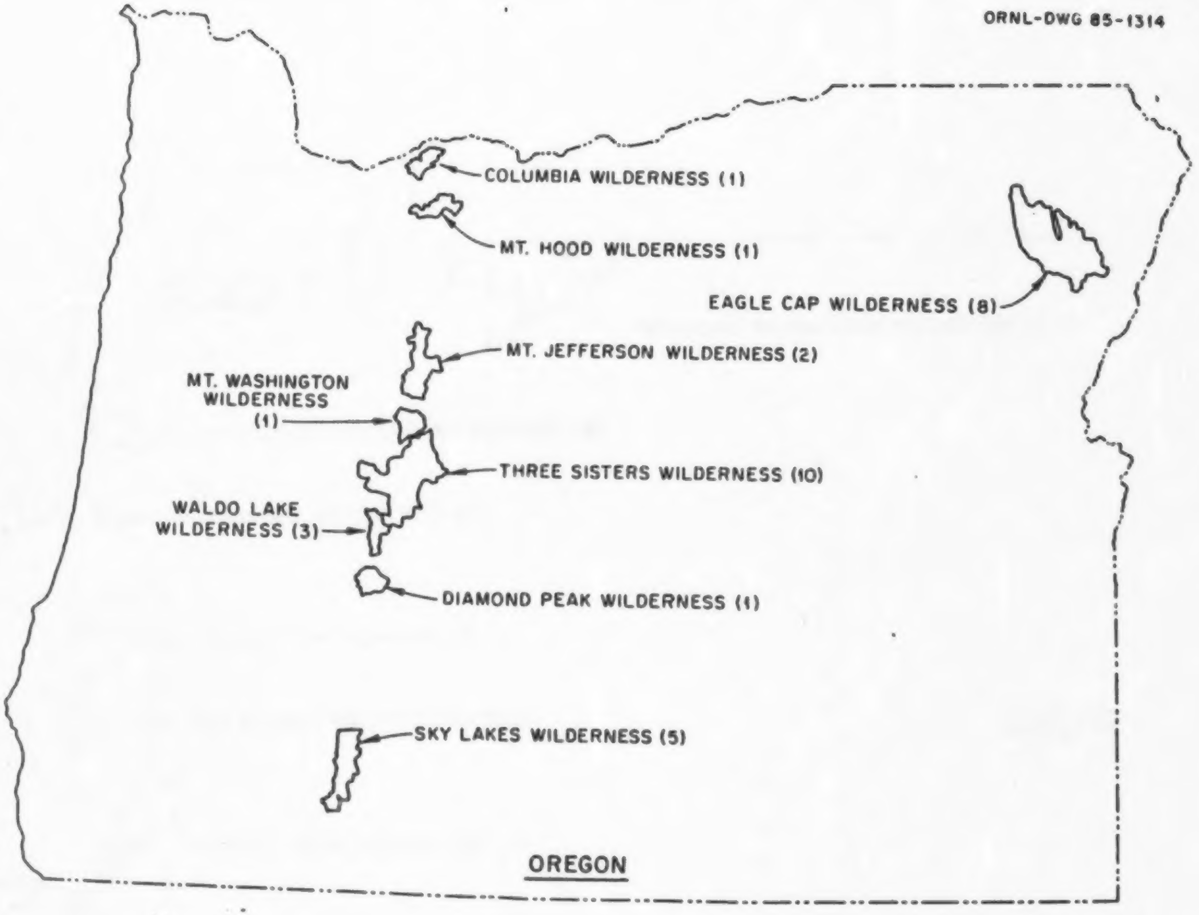
ORNL-DWG 85-1314
COLUMBIA WILDERNESS (1)
MT. HOOD WILDERNESS (1)
EAGLE CAP WILDERNESS (8)
MT. JEFFERSON WILDERNESS (2)
MT. WASHINGTON WILDERNESS (1)
THREE SISTERS WILDERNESS (10)
WALDO LAKE WILDERNESS (3)
DIAMOND PEAK WILDERNESS (1)
SKY LAKES WILDERNESS (5)
OREGON

Fig. 3.2-5. Wilderness areas and national parks in Oregon with lakes proposed for sampling in the NSWS (number in parentheses indicates the number of lakes in each area or park).

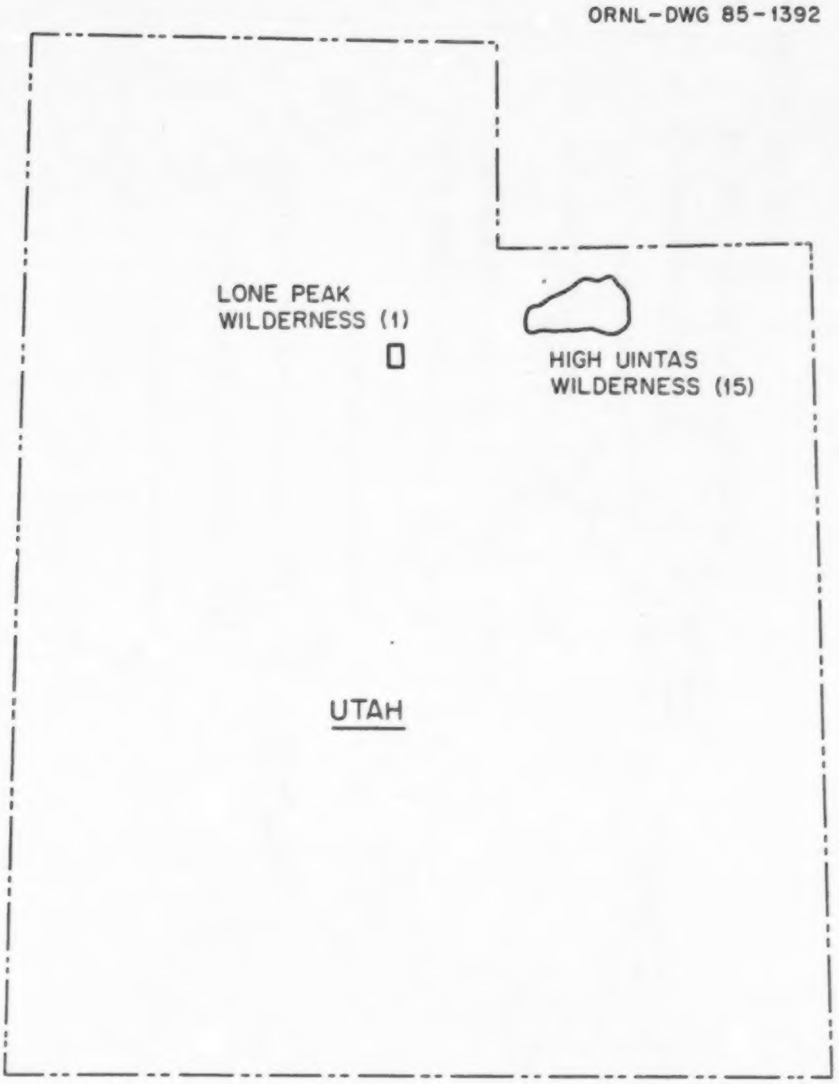
ORNL-DWG 85-1392
LONE PEAK
WILDERNESS (1)
HIGH UINTAS
WILDERNESS (15)
UTAH

Fig. 3.2-6. Wilderness areas and national parks in Utah with lakes proposed for sampling in the NSWS (number in parentheses indicates the number of lakes in each area or park).

ORNL-DWG 85-1393

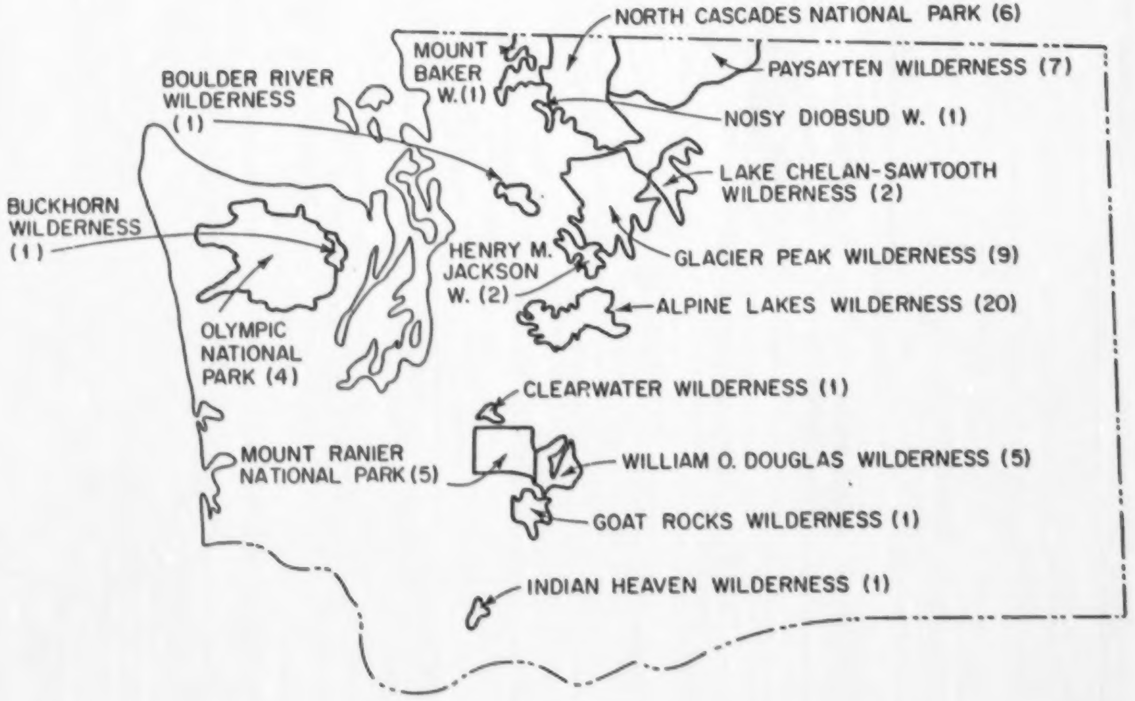
NORTH CASCADES NATIONAL PARK (6)
MOUNT BAKER W. (1)
PAYSAYTEN WILDERNESS (7)
BOULDER RIVER WILDERNESS (1)
NOISY DIOBSUD W. (1)
LAKE CHELAN-SAWTOOTH WILDERNESS (2)
BUCKHORN WILDERNESS (1)
HENRY M. JACKSON W. (2)
GLACIER PEAK WILDERNESS (9)
ALPINE LAKES WILDERNESS (20)
OLYMPIC NATIONAL PARK (4)
CLEARWATER WILDERNESS (1)
MOUNT RANIER NATIONAL PARK (5)
WILLIAM O. DOUGLAS WILDERNESS (5)
GOAT ROCKS WILDERNESS (1)
INDIAN HEAVEN WILDERNESS (1)

Fig. 3.2-7. Wilderness areas and national parks in Washington with lakes proposed for sampling in the NSWS (number in parentheses indicates the number of lakes in each area or park).

ORNL-DWG 85-1317

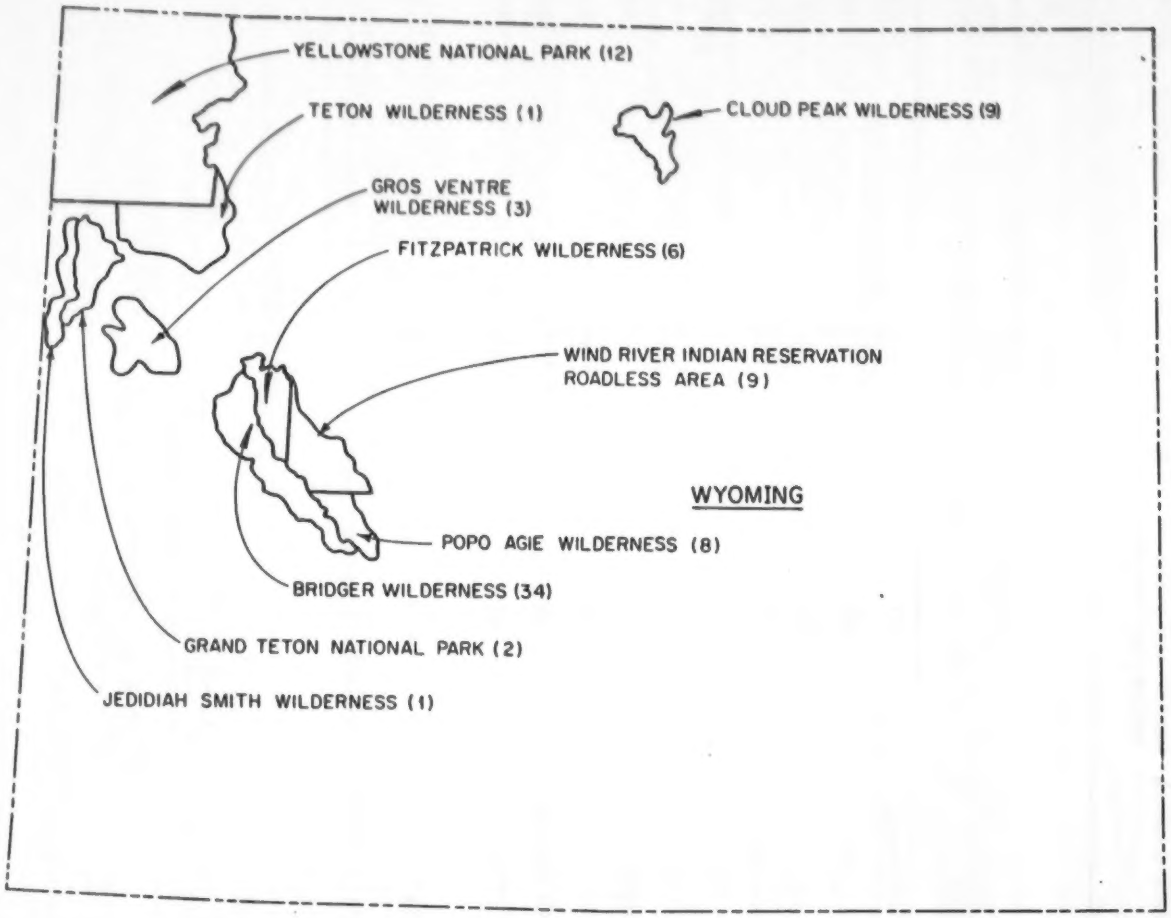
YELLOWSTONE NATIONAL PARK (12)
TETON WILDERNESS (1)
CLOUD PEAK WILDERNESS (9)
GROS VENTRE
WILDERNESS (3)
FITZPATRICK WILDERNESS (6)
WIND RIVER INDIAN RESERVATION
ROADLESS AREA (9)
WYOMING
POPO AGIE WILDERNESS (8)
BRIDGER WILDERNESS (34)
GRAND TETON NATIONAL PARK (2)
JEDIDIAH SMITH WILDERNESS (1)

Fig. 3.2-8. Wilderness areas and national parks in Wyoming with lakes proposed for sampling in the NSWS (number in parentheses indicates the number of lakes in each area or park).

Table 3.2-1. Distribution of lakes within and outside wilderness areas, by state

State	Within wilderness areas	Total number of lakes selected	Percentage within wilderness areas
California	101	168	60
Colorado	69	162	43
Idaho	47	85	55
Montana	45	111	41
New Mexico	1	3	33
Nevada	0	3	0
Oregon	32	64	50
Utah	16	35	46
Washington	52	131	40
Wyoming	62	126	49
Total	425	888	48

These wilderness areas are located in nine western states. These areas are usually typified by rugged terrain, steep slopes, and high altitudes. In many areas, slopes average above 30% and may go to 70%. Typical lower elevations range from around 3000 to 5000 ft above sea level, with typical higher elevations ranging from around 8000 to 12,000 ft above sea level. Commonly occurring features include high peaks and cliffs, deep narrow canyons, talus slopes, gently sloping meadows, and forested river bottoms. In many areas lakes and streams abound. Glacially created features such as cirques, U-shaped valleys, and moraines often occur, with glaciers still present in some areas. Soils in most cases are shallow, particularly on slopes, and are frequently poorly buffered and infertile. The diverse topography and altitude of some areas contribute to rapid and extreme weather changes.

3.3 BIOLOGICAL RESOURCES OF CONCERN

Although each of the wilderness areas encompassed by the study exhibits unique biotic characteristics, certain generalizations can be made. Composition of forest communities, which make up at least 60% of most areas, depends heavily on altitude and aspect. Major trees commonly encountered include various firs (Abies spp.); Douglas fir (Pseudotsuga menziessi); hemlock (Tsuga spp.); and a variety of pines (Pinus spp.), especially lodgepole (P. contorta), ponderosa (P. ponderosa), white pine (P. monticola), and whitebark pine (P. albicaulis). Alpine meadows and barren land are relatively common, particularly at higher elevations. Meadows often support lupines (Lupinus spp.), Indian paintbrush (Castilleja spp.), eriogonums (Eriogonus spp.), and a variety of grasses (e.g., Poa spp., Agropyron spp., Bromus spp., Festuca spp., and Bouteloua spp.)

Wildlife in wilderness areas includes many species that are sensitive to human presence or that require large areas of undisturbed habitat. Large predators found in one or more of the areas considered here are black bear (Euarctos americanus) and cougar (Felis concolor). Frequently encountered hooved mammals include mule deer (Odocoileus hemionus), black-tailed deer (O. crooki), elk (Elaphus sp.), moose (Alces alces), mountain goat (Oreamnos americanus) and mountain sheep (Ovis canadensis and O. dalli). Smaller mammals include mink and weasel (Mustela spp.), raccoon (Procyon lotor), bobcat (Lynx rufus), and coyote (Canis latrans). Blue and ruffed grouse are abundant in many areas and occur at least occasionally in others.

Many of the wilderness area lakes offer a sport fishery of native and introduced salmonids; in some cases, fish are stocked. Sport fish species include rainbow (including steelhead), golden, and cutthroat trout (Salmo gairdneri, S. aguabonita, and S. clarki), brook trout and Dolly Varden (Salvelinus fontinalis and S. malma), chinook salmon (Oncorhynchus tshawytscha), and grayling (Thymallus arcticus). Salmonids, including brook and rainbow trout, have been found to be susceptible to the effects of acidification in North America and Europe (e.g., Henriksen et al. 1984, Beamish and Harvey 1972).

3.4 ENDANGERED AND THREATENED SPECIES

Federally listed endangered terrestrial species (FWS 1984) which could be encountered in the NSWS include woodland caribou (*Rangifer tarandus caribou*) in the Selkirk mountains of northern Idaho and extreme northeastern Washington; the gray wolf (*Canis lupus*) in central Idaho, bald eagle (*Haliaaetus leucocephalus*), endangered throughout the conterminous United States except as noted below; whooping crane (*Grus americana*) in the Gray's Lake area of southeastern Idaho; and American peregrine falcon (*Falco peregrinus anatum*) throughout the region. Threatened species (FWS 1984) include the bald eagle, threatened in Washington and Oregon in the region of the NSWS; arctic peregrine falcon (*F. p. tundris*) throughout the region; and grizzly bear (*Ursus arctos horribilis*). The largest population of the latter occurs in the Yellowstone ecosystem (Yellowstone National Park and surrounding areas), where from 130 to 350 individuals are estimated to occur (Chapman and Feldhamer 1982). Other ecosystems where populations are known to occur are the Glacier National Park and Bob Marshall Wilderness Area, the Cabinet-Mountains and Selkirk Mountains, the Selway-Bitterroot Wilderness Area, and the North Cascades National Park (FWS 1982). Correspondence with the U.S. Fish and Wildlife Service concerning endangered and threatened species appears in Appendix B.

Four fish species considered endangered or threatened according to the U.S. Fish and Wildlife Service (FWS 1984) may be found in or near wilderness area lakes to be sampled in the NSWS. The endangered Kendall Warm Springs dace (*Rhinichthys osculus thermalis*) occurs near the Bridger Wilderness in Wyoming; the threatened Paiute cutthroat trout (*Salmo clarki seleniris*), Greenback cutthroat trout (*S. c. stomias*), and the Little Kern golden trout (*S. aquabonita gilberti*) are found in or near the John Muir, Mokelumne, and Ansel Adams Wilderness Areas and Sequoia and Yosemite National Parks (California); and Rocky Mountain National Park, and Comanche Peak and Indian Peaks Wilderness Areas in Colorado (Bureau of Sport Fisheries and Wildlife 1973; Lee et al. 1980; Ono et al. 1983). Although these are typically stream rather than lake species, cutthroat trout may also be found in mountain lakes (Lee et al. 1980).

4. ENVIRONMENTAL CONSEQUENCES

4.1 ALTERNATIVE 1 (USE OF HELICOPTERS ONLY)

4.1.1 Impacts to Wilderness Values

Of the major wilderness values described in Sect. 3.1.1, only the first two, experiential and mental and moral restoration would likely be affected by use of helicopters. Potential scientific values would remain unchanged because the proposed action under this alternative would leave no physical changes to the wilderness (landing only on water) and would have only a transitory impact on wildlife due to the helicopter's noise and appearance (see Sect. 4.1.3). In the event of a helicopter accident, slight, but transitory damage to the scientific value of the wilderness could occur as a result of fire, trauma to wildlife, or engine fuels or other fluids in or on water bodies. In terms of scientific values, the proposed NSWS survey itself is in keeping with the spirit of the Wilderness Act in that it would use the wilderness as a barometer, or yardstick, to further understanding of the threats of acidic deposition. The foremost value in wilderness management is taking those actions that preserve wilderness character, that maintain the integrity of the wilderness. To the extent that other alternatives cannot meet the timing needs and quality guidelines of the lake survey, Alternative 1 would be in keeping with the spirit and letter of the Wilderness Act.

Experiential values. The chief impacts to the experiential values (Sect. 3.1.1) associated with the various western wilderness areas would likely accrue from a public more concerned with the fact of an intrusion than with the specifics of the reasons for the intrusion. The enjoyment of nature is the primary value in the wilderness experience (Kaplan and Talbot 1983). The aesthetic benefit believed to be derived from enjoying nature is the highest benefit identified in psychological studies of the motivations people have for visiting wilderness areas. That the visual and audible presence of a helicopter would be incompatible with visitor's expectations of the aesthetic quality of a wilderness is clear. The loss of engine fuels or fluids from a leak could cast a transient shimmering slick on pristine-appearing waters and extend the perception of intrusion.

Precedents for helicopter use in wilderness areas do exist. Intrusions by helicopters in recent FS experience have been for fire suppression, snow level monitoring, repair of dams, search and rescue operations, placement of temporary seismic monitoring equipment, USGS survey and mapping, etc. Requests for permission to use helicopters have been denied to private mineral and energy exploration companies, certain USGS activities, some Soil Conservation Service (SCS) snow monitoring operations, etc.

A multiyear cooperative agreement regarding helicopter use, among other activities, between the FS and the USGS recently expired. Helicopters were used relatively frequently in wildernesses by the USGS to meet a December 31, 1983, time limit set in the Wilderness Act for filing a claim or leasing of oil or gas. In the past year, the use of helicopters by the USGS is being brought into compliance with the intent of the Wilderness Act (E. Bloedel, U.S. Forest Service, Washington, D.C., personal communication to C. Petrich, ORNL, Dec. 5, 1985). The FS is also becoming more restrictive in the terms of its agreements with local sheriffs' offices who are responsible for mounting the helicopter search and rescue team operations in emergency situations. Unwitting abuse of these agreements (searches undertaken when missing people are in fact no longer even in the wilderness) is a management problem in some areas, and the FS is trying to strengthen existing policies to minimize its occurrence (E. Bloedel, U.S. Forest Service, Washington, D.C., personal communication to C. Petrich, ORNL, Dec. 5, 1985).

As an example of the number of intrusions of helicopters into wilderness areas in a given year, data are available from Region 2 (Rocky Mountain Region) of the FS. In 1983, there were a total of 31 authorized helicopter operations in the various wilderness areas within the Region: 27 search and rescue missions, 3 USGS mineral surveys, and one other of unnamed mission (L. Carr, U.S. Forest Service, Lakewood, Colorado, personal communication to R. Cushman, Dec. 7, 1985). The distribution of these operations in time and space is not known. Whether these totals are representative of other FS Regions is not known.

Because the Wilderness Act appears to permit exclusionary administrative actions on the part of the FS only when a specific wilderness area is threatened (Sect. 3.1.3), the proposed helicopter use would not be justified. If, however, such administrative actions could be justified on the basis of a perceived lower-level threat to the entire system, or to significant portions of it, the action called for in Alternative 1 would also appear to be justifiable. Recent studies (cited in Sect. 1.2) suggest that a near-term threat to some specific wilderness areas may exist.

The proposed use of helicopters as EPA's preferred sampling access technique (Alternative 1), or in combination with ground-access surveying (Alternative 3), is predicated on the concept that long-term wilderness values are sufficiently threatened by acidic deposition to natural ecosystems to justify the temporary intrusion into wilderness by motorized equipment. The situation could be considered as homologous to that faced by wilderness managers dealing with helicopter use in fire suppression issues. In that situation, the long-term objective is to return fire to its natural role as a dynamic ecological force. Because of several decades of unnatural fire suppression activities prior to wilderness designation, some areas could not endure a conscious decision to let a naturally caused fire burn unchecked. Too much highly combustible natural fuel may have accumulated on the forest floor. A crown fire would likely develop which could devastate mature wilderness forests and have catastrophic consequences to lands adjacent to its boundaries. Over a long period of time, areas with too much natural fuel accumulation may be able to be managed to allow natural fires, but not by allowing each natural fire to burn uncontrollably. The confused public, only recently having been sensitized to the need to permit fire to play its natural role in ecosystem dynamics, would now find wilderness managers using mechanized equipment to fight fires. The education of the public needs to carry the whole concept through to the idea of gradual implementation.

Similarly, the proposed helicopter use would need to be explained to a public still learning about the meaning of dedicated wilderness. As a temporary, one-time use of mechanized equipment, Alternative 1 could be considered a step toward implementing a longer-range, higher objective for wilderness management -- the operation of only natural environmental processes in the wilderness. This is the meaning of an enduring, untrammeled setting. Figure 4.1-1 illustrates this point. A near-term, brief, minor negative wilderness encounter (the intrusion of helicopters) would occur to the visiting public with an impact represented by "zone A." By enduring the impact of this management action, severe ecosystem impacts (represented by "zone B") potentially occurring at a much later, indefinite future date would presumably be avoided. Thus, in both fire suppression activities and baseline acidic deposition data collection, exemptions of normal restrictions on mechanized equipment would be made so that at a later date wilderness values could be protected and enhanced in a totally natural way.

If helicopters are permitted to gain access to the survey lakes, an important perceived threat to wilderness values could occur in the sense that some people may see the action as setting precedent. If viewed as a precedent, Alternative 1 could be seen to, lead to other exceptions that could, in their totality, seriously damage short- and/or long-term wilderness character.

Mental and moral restoration. The proposed use of helicopters would cause substantial, but generally transitory, impacts to the sense of solitude and the opportunities it affords for restoration (see Sect. 3.1.1). Besides the noise, sight, and possibly, the blade blast of the helicopter, the mere fact of the occurrence of an activity which is believed to be unauthorized can be most disconcerting. In Kaplan's (1983) discussion of environments supportive of the restorative experience, he cites the importance of situations where people have a "sense of things being under control." From this line of thinking, the simple advance knowledge that a helicopter intrusion authorized by the FS may occur during a wilderness trip may be sufficient reassurance to the wilderness visitor that "things are under control." The reasons for the flight may not concern the visitor at all. The lack of advance knowledge (and 100% success in forwarning all wilderness visitors is unlikely) could completely disrupt the restorative wilderness experience for some visitors because the perception may be one of people getting away with something or doing something illegal - in other words, one of "things being out of control."

Kaplan (1983) and Hammitt and Brown (in press) cited the wilderness's lack of discrepant and distracting influences as being one of the principal reasons for its remarkable capacity to support the restorative experience. A temporary helicopter intrusion could have such profoundly negative effects on the sense of tranquility and compatibility with wilderness expectations that the experience could destroy the opportunity for reflection and integration discussed in Sect. 3.3. Kaplan (1983) writes that a restorative experience must, "at the very least, ... give one a sense of being away, both in the sense of change of scenery and also in the absence of the pressures, constraints, and distractions of the everyday environment." Not every visitor will be delighted that scientists are trying to solve the acidic deposition problem, even if the problem's continuation may in future years endanger the very wilderness they are enjoying. Some will see the intrusion, even if both it and its rationale (no matter how nobly stated) are known in advance, as distractions from the daily world that the visitor thought was left at the trailhead entry to the wilderness.

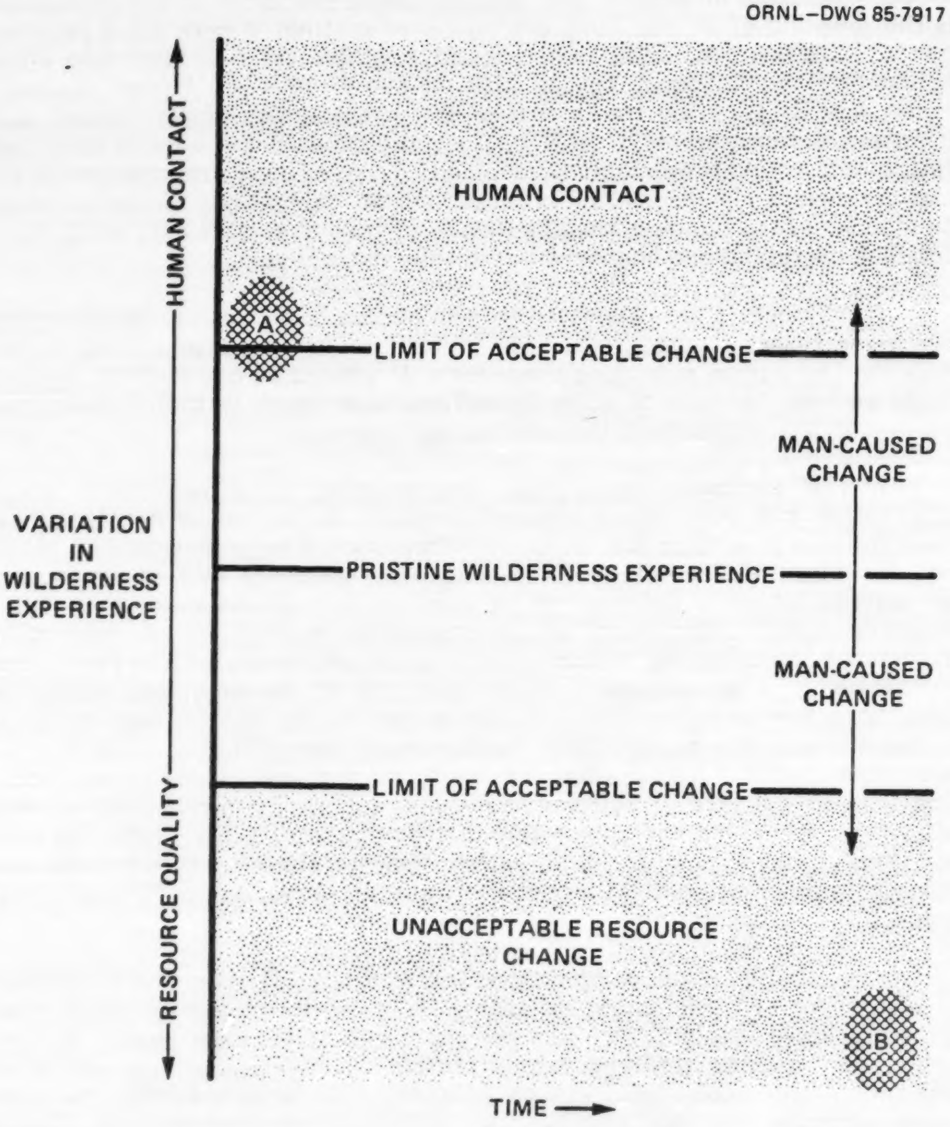
ORNL–DWG 85-7917
HUMAN CONTACT
HUMAN CONTACT
A
LIMIT OF ACCEPTABLE CHANGE
MAN-CAUSED CHANGE
VARIATION IN WILDERNESS EXPERIENCE
PRISTINE WILDERNESS EXPERIENCE
MAN-CAUSED CHANGE
LIMIT OF ACCEPTABLE CHANGE
RESOURCE QUALITY
UNACCEPTABLE RESOURCE CHANGE
B
TIME

Fig. 4.1-1. Relationship of proposed helicopter use to acceptable/unacceptable variation in perceived wilderness experience (modified from Hendee et al. 1978).

The restorative potential of wilderness is at its most effective when extended wilderness trips are undertaken. Kaplan and Talbot (1983) reported that participants in their studies did not show the most profound personal changes and feelings until the fifth through the seventh days in the wilderness. The changes occurring around the seventh day were at a significantly deeper level than those observable and described as being present on days three or four through five. These final changes were the ones that centered on reflection and contemplation -- the most elusive everyday pursuits. The noted wilderness backpacker Colin Fletcher has reported similar emotions within a similar timeframe, based both on his personal experiences and on his observations and discussions with others (Fletcher 1984).

The deepest psychological benefits from a wilderness experience appear to take at least a week to occur; they also are progressive in their occurrence. In a predictable order and pattern they gradually unfold, each successive benefit dependent on the preceding benefits, all creating an accumulative impact through time (Kaplan and Talbot 1983). Thus, the disruptiveness of the proposed helicopter use would have its most damaging effects on the restorative experience if it were to occur toward the end of an extended wilderness trip. Not only would it be most disruptive at that time, visitors' personal judgments of the aesthetic milieu surrounding the helicopter intrusion would likely be the harshest according to Kaplan and Talbot's research. No matter how long the trip, the earlier in the trip the intrusion occurs, the least impact it would have. As a final point, the research and observations reported above may be interpreted to suggest that the wilderness benefits of mental and moral restoration may be somewhat overstated for the average wilderness visitor. Hendee et al. (1978) report that less than 10% of wilderness visitors (even in the largest wildernesses) stay at least one week, and that the average stay in wildernesses in Washington and Oregon (for which such data were available) was from 2 to 3.5 d. They also cite that many small- or medium-sized wildernesses are predominantly day-use areas. Kaplan and Talbot report that the first significant stage in psychological benefits of wilderness does not begin to occur until between days three and four.

To the majority of wilderness users who can visit for only a brief time (1-2 d), the intrusion of a helicopter could be more of an irritant than a threat to a deeper psychological experience. The two types of impact, while different in kind, could be comparable in degree of negative effect on the wilderness experience.

4.1.2 Impacts to Recreation

While the most obvious wilderness use is recreational, it is not the primary reason the National Wilderness Preservation System was established. The Wilderness Act's objective is to preserve an enduring wilderness resource characterized by naturalness and outstanding opportunities for solitude; primitive recreation is provided for, with these goals as overriding constraints (Hendee et al. 1978). Hammitt (1982) found that the lack of manmade noises seemed to be more important to wilderness visitors' assessment of the quality of their experience then any other variable, even more than the lack of seeing manmade intrusions. Because the tranquility and sense of quiet order one expects in the wilderness would be disrupted by the proposed helicopter use, the following discussion first examines the nature of the noise impact before examining the impacts on specific recreational groups.

Noise. All recreational uses of wildernesses will be affected by the noise of the helicopters used in the proposed action. Helicopters at 500 ft are comparable in sound levels to heavy trucks and city buses heard from a street. Helicopter sounds are dramatically different in character, however, from other modes of transportation. Takeoff, landing, and flyover each has a different combination and intensity of sound. The two major components of noise are pitch (or frequency) and intensity (or amplitude). The most common unit used to measure loudness or sound intensity is the decibel (dB). The most common weighting system is the "A scale," written dB_A. It gives more weight to to the higher pitched tones which humans find more annoying, and thus the scale more closely matches the effect of sounds on humans than would a straight dB scale. Wildlife are known to be more sensitive to the lower frequencies, so the scale is not applicable when evaluating sound intensity impacts on animals. The dB_A scale is logarithmic. Table 4.1-1 displays noise levels commonly encountered and helps to place the sounds of the helicopters likely to be used in perspective.

A typical wilderness might have ambient noise levels in the range of 10 to 20 dB_A. EPA's Region 8 field crews have measured sound levels as low as 10 dB_A for extended periods of time in wilderness areas and national parks (L. Svoboda, EPA, Denver, Colorado, personal communication to Carl Petrich, ORNL, Feb. 13, 1985). There are no established standards for evaluating noise impacts in extremely quiet areas such as wilderness areas. Noise standards established for urban areas do not adequately apply to areas with very low ambient sound levels. Some scientists have suggested that simple audibility of noise serves as the best criterion of the level of impact in quiet areas (L. Svoboda, EPA, Denver, Colorado, personal communication to Carl Petrich, ORNL, Feb. 13, 1985). Thus a "psychoacoustic footprint" based on an "all-or-nothing" measurement of audibility means the proposed helicopter use would have a noise impact duration considerably beyond the lake approach, sampling, and take-off. Extensive empirical data are not available, but EPA scientists have collected data that suggest that sound intensities only 5-10 dB_A above ambient levels comprise the threshold of audibility.

A normal attenuation of 6-10 dB_A with each doubling of distance would not be applicable with the sampling in the proposed wilderness areas. Sound intensity attenuation is exacerbated by the low western humidities, the complex terrain, and the generation of sound over a cold water surface, which tends to hold sound downwards. The complex terrain around alpine lakes would most likely tend to reverberate, reflect, and refract sound in difficult-to-predict ways.

The loudest noise from the proposed helicopter use would be approximately 90 dB_A, at landing on the lake surface, 500 ft from an observer on shore. Appendix C gives a variety of expected sound exposure levels for a variety of receptor distances for takeoff, landing, level flyover, and various hovering regimes for the Bell long ranger, the helicopter, most likely to be used for sampling. From data in Table 4.1-1 and Appendix C, one can see that a typical wilderness visitor at a lakeshore would first encounter the sounds of a helicopter approaching from a level flyover altitude of 2000 ft. Exact data are unavailable on the intensity of this sound, but they would likely be in the vicinity of 40 dB_A. As the helicopter landed, the sound intensity to an observer located 500 ft from the deepest point of the lake would increase to approximately 80-90 dB_A. While on the water doing the sampling (15-20 min), sound intensities

Table 4.1-1 Intensity of helicopter noise[a] relative to common noise levels

Example	Decibels dB_A	Effect with prolonged exposure
Jet takeoff (close range)	150	Eardrum ruptures
Thunderclap, jet takeoff (200 ft)	120	Human pain threshold
Steel mill, live rock music, riveting, auto horn (3 ft)	110	
Jet at 1000 ft, subway, outboard motor, power mower, motorcycle (25 ft), farm tractor, jackhammer,	100	Serious hearing damage (8 hours)
Helicopter[a] at a landing or takeoff; busy urban street, diesel truck	90	Hearing Damage (8 hours)
Helicopter[a] hovering at 5-foot height; freight train (50 ft); clothes washer, average factory; garbage disposal; noisy office	80	
Helicopter[a] on water surface with main rotor maintained at 100% RPM (66-74 dB_A); freeway traffic (50 ft); vacuum cleaner;	70	Annoying
Helicopter[a] on water surface with main rotor maintained at 67% RPM (56-66 dB_A); conversation in restaurant; typical suburb	60	Intrusive
Quiet suburb (daytime), conversation in living room	50	Quiet
Library	40	
Quiet rural area (nighttime)	30	
Whisper, rustling leaves*	20	Very quiet
Breathing	10	
	0	Threshold of audibility

[a] Referenced to a human standing 500 feet from the source.

*Typical ambient sound levels in wilderness areas would range from 10 to 20 dB_A.

Source: after Miller 1975 and Newman, et al. 1984.

would range from 56-66 dB_A if a reduced engine-idle speed could be maintained or 66-74 dB_A if full engine idle speed was necessary. Takeoff sound intensities would decrease with ascent from 83 dB_A to the level during flyover (40 dB_A and less) as the helicopter flew from the area. Table 4.1-1 permits the reader to correlate these sound intensities to more familiar noises.

Helicopters are acoustically complex machines that generate noise from two primary areas: the main rotor, tail rotor, aerodynamic noise, compressor tones, and the gear train; and blade vortex interaction and high advancing tip Mach numbers (Newman et al. 1984). The latter noise-generating mechanisms are both associated with in-flight effects and both produce impulsive noise (e.g. "blade slap"). Blade slap is commonly heard in the approach operational mode (landings) as a result of the interaction between air vortices generated by the main rotor action colliding with successive sweeps of the rotor blades during descent. This generally annoying sound phenomenon is maximized for certain helicopters at airspeeds in the 50- to 70-knot range, at rates of descent ranging from 200 to 400 ft/min. Changing the angle of descent from 6 degrees to 9 or 12 degrees can decrease the noise generated by 3 to 6 dB_A while the same air speed is maintained.

The FAA has developed most of its data and policies for addressing helicopter noise in urban or suburban areas. Their advisories are not directly applicable to wilderness areas where ambient levels are so low that mere audibility is the critical factor. The FAA supports a "Fly Neighborly" program initiated by the various helicopter manufacturers. This voluntary program educates pilots as to the tradeoffs that they can make in air speed, angle of descent, and resultant noise while flying in sensitive areas. The tradeoffs not only involve diminishing noise levels at one location while increasing them at another, but also must involve balancing safety factors and the passenger discomfort of too rapid decelerations or rates of descent. Pilots will always give safety the greatest weight in any consideration of these factors.

Exact noise prediction is dependent on the specific type of helicopter, its maintenance quality, the terrain conditions, the flight path trajectory, and upper air meteorological characteristics such as temperature, relative humidity, wind direction, and wind speed. While a helicopter increases its air speed, two acoustically related events occur: the actual duration of the noise over a given point will decrease because the helicopter will pass more quickly; and a noise intensity vs air speed relationship approximating a parabolic curve begins. As the helicopter increases its speed beyond that necessary for minimum power, the power required (torque) increases with an increase in air speed. Initially, the noise levels decrease with increasing airspeed, but then an upturn occurs as a consequence of increasing advancing blade tip Mach number effects, which in turn generate impulsive noise (blade slap). Generally, noise increases rapidly when the Mach number increases beyond 0.8 (Newman et al. 1984). Each manufacturer can supply the appropriate "Fly Neighborly" cruising speed, or the speed at the nadir of the noise intensity/air speed parabola. The trade-off here would be that flying at the best "Fly Neighborly" cruising speed would mean an extended duration of the "psychacoustical footprint."

Hiking and horseback riding. The dominant impacts of the proposed helicopter sampling associated with these recreational activities would be the sight and sound of the helicopters either landing and doing the sampling or flying overhead (or both). The psychological dimensions of these impacts were discussed in Sect. 4.1.1. Because hiking and riding are the chief means of travel in wilderness areas, impacts on these activities pervade nearly all other wilderness activities. The general aesthetic context of wilderness in which other recreational pursuits take place is frequently the dominant reason for being in the wilderness. In one wilderness (Alpine Lakes), studies found that 80% of the fisherman indicated they visited the lakes for reasons other than or in addition to fishing. Similar findings were made in the Desolation Wilderness. The Alpine Lakes studies found that

> only about 40% of the visitors to the lakes actually fished, only 40% of the parties contained fisherman, anglers fished an average of less than two hours per day, and 40% of them caught no fish. An equally important finding: non-fishermen spent just as much time at the lakeshore as anglers. Other studies...confirm that, on the average, only about half the visitors to wilderness high lakes actually fish (Hendee et al. 1978).

Thus, the water-focused activities are multipurpose and have more passive recreational activities such as hiking, camping, nature appreciation, and photography among their major foci.

Because of the importance of hiking or riding as primary activities or as a means to pursue other activities, use patterns in most wildernesses are highly trail related (Fig. 4.1-2). Forest Service studies have found that fewer than 20% of the wilderness visitors do any cross-country traveling, and only a subset of this group does any off-trail traveling (Hendee et al. 1978). The impact on those who do make the effort to get off the formal trail system and "away" would presumably be substantially greater than to those who follow the established trails. In more open country or above timberline, one will find more off-trail use. In heavily forested and extremely steep areas, nearly all travel is restricted to trails. Because of this, the flightpaths of the helicopter overflights could be sensitively planned in many areas to avoid most wilderness users (Sect. 4.1.6).

Camping sites are also highly clustered. In a study of the Desolation Wilderness, the most popular 16% of the camping sites accounted for one-half of all use; the least used one-half comprised only 18% of all use. In studies of the Spanish Peaks area and the Bridger Wilderness Area, 85% of the campsites were found to be within 200 ft of either a lake or stream (Hendee et al. 1978). The proposed action would unavoidably encounter numerous recreational users because of the lakes being the EPA's focus of interest, too.

Thus, other than for trails and camping sites, relatively little direct use is made of the wilderness's vast acreages. Hendee et al. (1978) report that managers of the John Muir Wilderness Area estimated that only about 2% of the area was actually used directly. The primary use of this land is as a stage for the wilderness experience to occur, and, as stated earlier, the aesthetic benefit is the most highly valued of the wilderness experiences. To the extent that the proposed helicopter use avoids appearing visually and audibly within this stage, the survey

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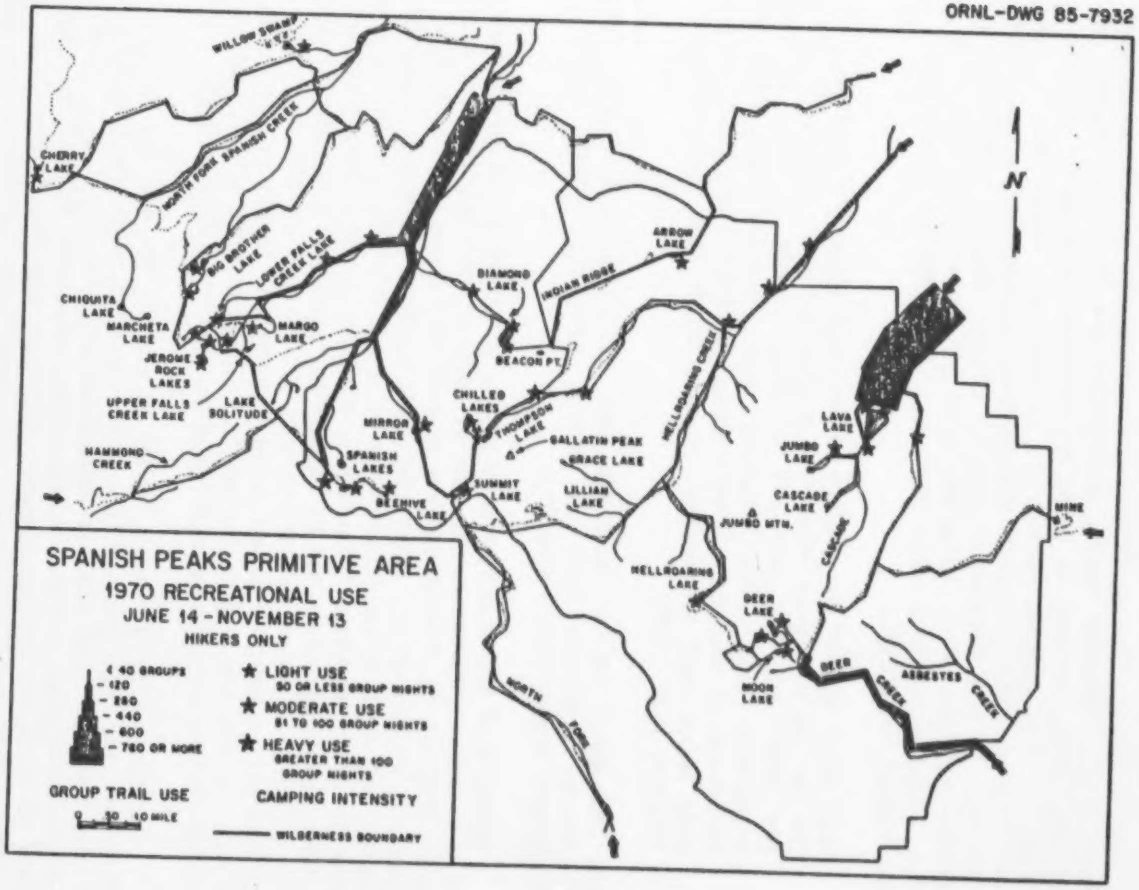
SPANISH PEAKS PRIMITIVE AREA
1970 RECREATIONAL USE
JUNE 14 - NOVEMBER 13
HIKERS ONLY
≤ 40 GROUPS
– 120
– 280
– 440
– 600
– 760 OR MORE
GROUP TRAIL USE
★ LIGHT USE
50 OR LESS GROUP NIGHTS
★ MODERATE USE
51 TO 100 GROUP NIGHTS
★ HEAVY USE
GREATER THAN 100 GROUP NIGHTS
CAMPING INTENSITY
0 5.0 10 MILE
WILDERNESS BOUNDARY
N
CHERRY LAKE
WILLOW SWAMP
NORTH FORK SPANISH CREEK
BIG BROTHER LAKE
LOWER FALLS CREEK LAKE
CHIQUITA LAKE
MARCHETA LAKE
MARGO LAKE
JEROME ROCK LAKES
UPPER FALLS CREEK LAKE
LAKE SOLITUDE
HAMMOND CREEK
MIRROR LAKE
SPANISH LAKES
BEEHIVE LAKE
DIAMOND LAKE
INDIAN RIDGE
ARROW LAKE
BEACON PT.
CHILLED LAKES
THOMPSON LAKE
GALLATIN PEAK
GRACE LAKE
SUMMIT LAKE
LILLIAN LAKE
HELLROARING CREEK
HELLROARING LAKE
JUMBO MTN.
LAVA LAKE
JUMBO LAKE
CASCADE LAKE
CASCADE
DEER LAKE
MOON LAKE
DEER CREEK
ASBESTOS CREEK
MINE
NORTH FORK

Fig. 4.1-2. Distribution of recreational use, Spanish Peaks Primitive Area, Montana, 1970 (Source: Hendee et al. 1978).

would go largely undetected. To the extent that encounters occur at more frequented spots, the higher the impacts would be. To the extent that encounters are on the periphery of the wilderness, the less the impact may be (some peripheral areas may, however, be the most remote areas in the wilderness and, thereby, the most sensitive to the wilderness visitor who has made the extra effort to seek solitude there). Generally, however, there is an expectation of more likelihood for more disruption from other visitors when on the periphery of wilderness areas (Hendee et al. 1978). Impacts at campsites would be more disruptive than on trails, and impacts in remote, internal locations could be the greatest, despite their location. While fewer in number, visitors there are presumably the most sensitive to disruptions.

The wildlife aspects of the aesthetic experience of wilderness would be affected briefly by the proposed use of helicopters for the survey. Some people's main motivation in seeking wilderness is to observe and photograph native species in natural settings. There is a rich cultural heritage of wildlife being used as an indicator of the wildness of a given location. Grizzly bears connote the wildlands of Yellowstone and Glacier National Parks to most of America. To the ecologically informed, wolves and wolverines are true indicators of wilderness; they reflect the substantial absence of human influences. Hendee and Schoenfeld (1978) remark that "simply knowing such wildlife is present is important in the meaning of wilderness."

For the serious wildlife observer, the grizzly bear and the bighorn sheep are the most desired species to find in wilderness. The proposed helicopter use could temporarily disrupt efforts to observe either of these species, particularly bighorns. If an opportunity to observe these or other high-preference species is lost, the proposed helicopter use would have a significant negative impact on a visitor's wilderness experience. The serendipitous encounter with many wild species may be an even larger thrill to the wilderness visitor than successful sightings by visitors who have come searching for certain species. The reward of discovery, of the unexpected, of unique outdoor experiences is much of what wilderness can deliver to the visitor. To visitors who do not have chance observations of certain species or who miss fortuitous encounters with an area's wildlife because of the disruption caused by helicopter use, a degradation of their potential wilderness experience would occur, even if they are unaware of what they missed. For the serious wildlife observer specifically looking for certain species (see the discussion in the hunting section, below), the opportunity to see mountain goats or sheep should well remain after helicopter disruption because after an initial, brief fright response, these species revert to their predictable patterns of movement and should be easily found again (Hendee and Schoenfeld 1978).

As a comparison, the proposed helicopter use and hunting offers a perspective on the relative degree of disruption and noise. From the perspective of the wildlife experiences discussed above, the proposed helicopter use would likely have less impact than would a typical hunting season. During hunting season, a rifle shot (or series of shots) scaring away wildlife and breaking the tranquility and solitude would be extremely disruptive to some wilderness visitors, particularly so to those who do not know hunting is a permissible activity in most wildernesses. After hunting season, some significant time may need to elapse before game return to their normal movement, bedding, and feeding patterns.

Visitors during this interim period could completely miss the wildlife. Over the years, hunting pressures and disturbances may effect changed wildlife behavior patterns. The proposed helicopter use is a one-time occurrence.

Fishing. That some wilderness lakes are stocked with fish to enhance the fishing experience, that some are stocked that were barren prior to man's discovery of the lakes, and that some are even stocked by aircraft (if the practice preceded wilderness designation) provides a context in which to assess the suggestion that the proposed helicopter use is disruptive to fishing opportunities in the wilderness. The threat of acid rain to aquatic life is a direct one in some wilderness lakes, and the proposed survey would provide information useful in providing relief to the fishery resource. The most serious impact to fishing as a recreational activity would be the impact on the aesthetic dimension of the fishing experience. It should be recognized that some anglers resent any intrusion by anyone into remote areas they have sought out with strenuous effort. The proposed helicopter use, in that the technique involves sampling away from the shoreline at the deepest point in each lake, would have minimal impact on the fishing potential on a given day.

Hunting. As with fishing, hunting as a recreational activity in the wilderness brings with it some controversy. Because no hunting occurs in national parks, many wilderness visitors falsely believe that it is an illegal activity in wilderness areas. The Wilderness Act passed on the management of wildlife in the new areas to the states, just as it had been their responsibility when the lands were national forests. Because of game-protection practices on lands adjacent to wilderness, the management challenge within the wilderness can at times be compounded. The lack of natural predators to larger game species can lead to excessive populations. Natural predators can be as scarce in wilderness areas as they are in the general lands surrounding the areas. Therefore, hunting serves to protect the vitality of the population of wilderness game. Controversy again enters the picture in that hunters are perceived by some wilderness visitors as being insufficiently selective with respect to age and sex of their game to ensure that the natural behavior and dynamics of the game populations are maintained. Hunting is not seen by many as mimicking the patterns of kill that natural predators would perform. As an example, trophy bighorn rams serve a prime role in the breeding pattern of the herd. Their elimination arguably weakens the long-term vitality of the herd, part of the enduring wilderness character of the area.

The earlier discussion (Sect. 3.3) of using wilderness-dependent activities vs wilderness-associated ones as guides to making wilderness management decisions has direct application to the potential conflict between the proposed helicopter use and hunting. The proposed action is decidedly dependent on wilderness (Sect. 2.1, etc.). Section 4.4.6 and Table 4.4-1 underscore the relationship between wilderness lakes, low alkalinity classes (vulnerability to acidification), and the ability to make accurate regional characterizations of the acidic deposition problem. Hunting for some species (such as bighorn sheep or mountain goats) is essentially wilderness dependent. For others, such as deer or elk, it is not particularly wilderness dependent, except in the respect that the satisfaction derived from stalking the game may be perceived as only being achievable to the desired level in a wilderness setting. Thus, the conflict can, for some species and some hunters, be resolved on a wilderness-dependency basis.

Popular big game species such as Bighorn sheep and mountain goats are creatures of quite predictable habits. If they are startled by the sight and sounds of the proposed helicopter use, the fright response would be temporary. Hendee and Schoenfeld (1978) report studies that show that such animals can be readily tracked (by experienced hunters) after such a disruption; presumably, the hunt could then soon be resumed. Some hunts would be disrupted psychologically, if not physically, if hunters were unable to reschedule a planned trip and had to commence the hunt knowing that, weather permitting, a helicopter might fly overhead and/or land on a given lake along their proposed route.

4.1.3 Impacts to Wildlife and Endangered Species

Wildlife. The most likely adverse impact on wildlife associated with the use of helicopters would be the effects of noise. Most noise effects, however, have to do with long-term exposure to relatively high levels and the consequent permanent effects on health, physiology, or behavior. In the present case, the only probable effect of one or, at most, several overflights by helicopters would be a startle or fright response. Except in the relatively unlikely event of an accident suffered by a frightened animal, such impacts would be minor and transitory. Observations show that a variety of wildlife species may be frightened by noise and visual perception of both rotary and fixed wing aircraft. Of note for wildlife species in the western region are Canada geese, bears, antelope, deer, elk, wild sheep and goats, and a variety of small mammals (Dufour 1980). Lakes to be sampled in Olympic National Park are in areas used by elk during the mid-September rutting season (NPS 1985). It is highly desireable to avoid disturbing these animals during this time. The fact that effects are in most cases relatively minor is supported by the widespread use of helicopters to enumerate big game, including bears, mountain sheep and goats, caribou, and wolves (Chapman and Feldhamer 1982).

Endangered and threatened species. Potential impacts of helicopter use on endangered and threatened species are the same as for other wildlife, but are of greater concern because populations of these species may be particularly susceptible to damage. Thus, noise from helicopters during nesting seasons of bald eagles or staging of whooping cranes, for example, could disrupt these critical reproductive activities and contribute to threats to the species' continued existence. The timing and nature of the proposed activity under this alternative, however, make significant impacts to endangered species very unlikely, with two possible exceptions.

The sampling window, (i.e., September to October 15th) for the region occurs after nesting and fledging of avian endangered species (bald eagle, peregrine falcon, and whooping crane). On the other hand, where lakes are near eagle or falcon sites, juveniles may remain in the nest area during the postfledging period [i.e., around August 15 (D. Flath, Montana Dept. Fish, Wildlife, and Parks, Bozeman, Montana personal communication to J. W. Webb, ORNL, Dec. 11, 1984) and close coordination with wildlife officials would help minimize any problems.

Although staging by whooping cranes may occur during the sampling period, the random selection process produced no lakes in the Gray's Lake area, where efforts are under way to establish a whooping crane flock by using sandhill cranes as foster parents. Grizzly bears have been observed to exhibit fright or aggressive behavior in response to aircraft (McCourt et al. 1974), but their reactions are extremely individualized and are, in any case, unlikely to endanger an affected animal's life or health. The continuing use of helicopters and fix winged aircraft to census grizzlies (Chapman and Feldhamer 1982) is testimony to the low risk of significant impacts. Aircraft noise is also known to frighten caribou herds (Jakimchuk et al. 1974), and a stampeding herd could sustain injury or death of some individuals. In the case of the small remaining group of woodland caribou (about 13 to 20 animals) in the Selkirk mountains of Washington, Idaho, and British Columbia, such an event could be a serious. However, given the information on the distribution of this herd (USFWS 1984), and of the lakes to be sampled (Appendix A), and encounter is very unlikely. Because the herd includes radio-tagged individuals (USFWS 1984), and potential encounter could be avoided by careful planning at the time of sampling.

Even though four endangered or threatened fish species [a dace and three trout species (Sect. 3.3)] may be found in or near wilderness areas to be sampled in the NSWS, no adverse effects would be expected except in the unlikely event of a large accidental fuel spill into a small water body containing the species (Sect. 4.1.4).

4.1.4 Impacts to Water Bodies

The major potential source of environmental impact to water bodies would be a spill or leak of fuel from the helicopters into the lakes being sampled. Leaks of hydraulic fluid and spills of other materials (pH standard solutions, freeze-gel packs) could also occur.

Given a minimum lake size of approximately 1 ha (USEPA 1984a) and assuming that the mean depth of the lakes would be at least 1 m, then the minimum lake volume to be affected by a hypothetical spill would be 10,000 m^3 (although smaller water bodies could be affected by spills or leaks while the helicopter was en route).

A hypothetical spill of 100 L of fuel into a lake of this size would represent a maximum concentration (after complete mixing and ignoring processes such as volatilization) of approximately 10 ppm. In fact, evaporation is likely to be at least 100 times as great as dissolution for volatile hydrocarbon mixtures such as aviation gasoline or jet fuel, and dissolved hydrocarbon concentrations would probably be less than 1 ppb within minutes (McAuliffe 1979). Based on data for jet fuels summarized by Burks (1982, page 21), a concentration of 0.1 ppm (equivalent to 10 ppm divided by 100, to account for evaporation) would be less than the "no-effect" level for some fish species; a concentration of less than 1 ppb would not be expected to be toxic to fish or their eggs. The potential for effects would depend on many factors, including the amount and type of fuel spilled; size of the lake affected; physical and chemical factors such as wind, insolation, and mixing; and species and life stages present at the time of the spill. For all but the smallest water bodies that could be encountered, no significant toxic effects would be expected, but a visible sheen might result from any hydrocarbon spill or leak.

4.1.5 Impacts to Human Safety

The major impact to human safety from helicopter use in the proposed water sampling procedures would be to the survey crew from an accident. Because horseback riding is a common mode of wilderness travel, the potential exists for a helicopter to scare a horse and cause injury to humans. During the decade of the 1970s, the rate of occurrence of rotorcraft accidents decreased from 30.5/100,000 h flown in 1970 to 11.3 in 1979 [National Transportation Safety Board (NTSB) 1981a]. Fatal accidents have dropped from 2.5/100,000 h flown in 1970 to 1.5 in 1979. These decreases in the accident rates have been accompanied by an 11% annual increase in the number of hours flown in the same period.

Appendix B contains data that offer an assessment of recent historic helicopter accidents. From these data one can make projections about the probability of accidents occurring during the proposed helicopter use. No accident data are known to exist for high-altitude, wilderness area or general high-altitude helicopter use. Data from the NTSB have been used as a substitute for these, with the caveat that conditions in the rugged terrain of the mountainous West are demanding of the most experienced pilot's skills. In the unlikely event of an accident during the proposed NSWS survey, a chain of other impacts involving search and rescue and salvage operations would begin and could involve dangerous mountain rescues by helicopters and/or climbers, as well as the possibility of forest fire caused by a crash.

The high altitudes and mountainous terrain associated with the proposed helicopter use involve dangerous flying conditions. Huge and difficult-to-see downdrafts or tailwinds can be caused by sharp changes in the terrain and sudden changes in weather (G. Schaller, U.S. Forest Service, Red Lodge, Montana, personal communication to C. Petrich, ORNL, Dec. 12, 1985). Takeoffs and landings become much more demanding than in level terrain, low-altitude flying (M. Martin, Office of Aircraft Services, U.S. Department of the Interior, Boise, Idaho, personal communication to C. Petrich, ORNL, Feb. 7, 1985).

Assuming, conservatively, that it could take two helicopter flight-hours per lake sampled (about twice the duration for the lakes sampled in the East), and that there were at most 435 wilderness area lakes to be sampled, the total flight exposure for the proposed action would be under 1000 h. Using these assumptions and using calculations based on the binomial distribution (Snedecor and Cochrane 1967), one could project about one chance in ten (or 0.1 accident per 1000 h) that an accident could occur at some time during the proposed helicopter use in the NSWS survey program in the western wilderness areas. These estimates, while conservative, have not been adjusted for the high-altitude nature of the proposed action. They are consistent with historic accident records maintained by the Office of Air Services (Department of the Interior, Boise, Idaho) who coordinate the operation of many high altitude helicopter flights (R. Lewis, U.S. Department of the Interior, Boise, Idaho, personal communication to R. Crowe, EPA, Las Vegas, Nevada, Jan. 25, 1985) for federal data collection and environmental monitoring activities.

4.1.6 Mitigation Measures

In all cases, there will be close coordination between EPA and FS or other land management agencies to determine site-specific mitigation measures to reduce environmental conflicts. To ensure accountability for implementation of the mitigation measures, the following would be planned. Training for the base coordinators, duty officers and survey crew would be scheduled in late August and early September. This schedule would permit all specific mitigation concerns to be included in the training. Along with this training a reporting system would be used to ensure that the mitigation measures identified in the NEPA process are implemented. The helicopter contracts would include conditions which address mitigation applicable to helicopter pilots and their flight activities. These conditions could be reviewed at the special contract award meetings. The base coordinators would ultimately be responsible for implementing the mitigation that is identified in the NEPA process. Their efforts to adhere to the mitigation measures would be monitored and coordinated by the EPA regional logistics manager in Seattle. The following paragraphs identify programmatic areas of concern.

Wilderness Values

Mitigative measures for helicopter noise would have some effect in diminishing the impacts of the proposed action on the wilderness' potential for restoring mind and spirit. A public involvement and awareness plan jointly implemented by the FS and the EPA would also help in this regard, as discussed in Sect. 1.4. This information plan should include presentations to environmental groups; notices of the pending action, to be posted at all entrances to affected wildernesses; the preparation of news releases for newspapers, radio, and television; the preparation of articles for state fish and game or conservation magazines; and the planned cooperation with television to videotape an actual sampling process. The FS personnel should cooperate in informing all visitors inquiring about hiking or horseback riding opportunities of the potential conflicts with their objectives. Where disruption is unavoidable, the FS should explain the benefits of not having the latter stages of a trip affected.

The involved federal agencies could see the public involvement plan as an opportunity to educate the public, using the proposed action as just one of a constellation of issues and pressures that wilderness managers face: long-term wilderness values -- the natural progression of ecological processes -- that could be affected by acidic deposition at a barely perceptible rate traded off against the short-term degradation (from helicopter use) of expected wilderness values for wilderness visitors on a given day (Fig. 4.1-2). The authorization for this exclusion from wilderness regulations should be presented in a way that makes it clear to the public that the action is grounded in wilderness law and policy, that it is consistent with FS practice (in both space and time) and concern for an enduring wilderness, and that such concern for the long-term wilderness character necessitates this brief departure from the expected maintenance of immediate, more tangible wilderness values (Fig. 4.1-1). Hendee et al. (1978) advise that wilderness management decisions should favor those actions that provide the greatest range of future options. The proposed helicopter use could reasonably be justified in this regard.

Human Safety

Turbine-powered rotorcraft should be used for their greater safety, higher reliability, and higher power in difficult high-altitude conditions. All aircraft should be outfitted with rupture-resistant fuel cells to protect against a fuel spill in event of an accident (Wimpy Pybus, Federal Aviation Administration, Washington, D.C., personal communication to C. Petrich, ORNL, Dec. 3, 1985; D. Griffiths, U.S. Department of the Interior, Boise, Idaho, personal communication to C. Petrich, ORNL, Feb. 7, 1985). At the higher elevations of many of the wilderness lakes, available biomass and oxygen are limited, so significant fire risk (Sect. 4.1.5) is remote (M. Rogers, Aviation Planning Group, Aviation and Fire Management Staff, U.S. Forest Service, Washington, D.C., personal communication to C. Petrich, ORNL, Dec. 5, 1984). In gaining access to these lakes, however, the helicopters will have to fly over substantial forests during the fire season. As the accident rates show, more accidents occur during normal cruising than during take-offs or landings (these relationships shift to takeoffs and landings at the higher altitudes). Using experienced pilots (experience judged in terms of total flying time, flying time in the rotorcraft to be used, flying time in high altitude mountainous terrain, and recent flying time in the rotorcraft to be used) and carefully controlling the amount of time the pilots are allowed to fly should all assist in minimizing accidents. As the statistics suggest, however, there are no guarantees against problems. Decisions regarding method, timing, and even desirability of removing a crashed helicopter need to be made on a case-by-case basis (Ed Bloedel, U.S. Forest Service, Washington, D.C. personal communication to C. Petrich, ORNL, Dec. 5, 1984).

The record of the flight crews during the eastern and midwestern portions of the survey showed good judgment in dealing with a variety of weather conditions (see Appendix D), and no accidents occurred. While high altitudes and mountainous terrain were not factors there, other extreme hazards to helicopter safety were present, such as electrical and telephone wires and other obstacles associated with high-density populations. In the West, pilots with considerable experience with an even greater range of weather conditions and unusual winds associated with mountainous terrain would be needed. Emergency landing sites should abound at the higher elevations (either water or rock outcrops), but could present a problem in the more forested areas at lower elevations.

The two biggest dangers to helicopter flights in mountainous terrain at high altitude are related to pilot (or other human) error and are, therefore, avoidable (M. Martin, U.S. Department of the Interior, Boise, Idaho, personal communication to C. Petrich, Feb. 7, 1985). The first is related to carrying too much weight for the altitude. When carrying more than the maximum allowable grow weight for a given temperature an altitude ("density altitude"), loss of control can occur on landing. Pilots need to frequently consult their rotorcraft performance charts and compare the weight being carried to the current density altitude. External air temperature forecasts are available from flight centers and from the helicopter outside air temperature gauge while in flight.

The second danger involves the pilot's ability to read and react to downdrafts and tailwinds while maneuvering in mountainous terrain. While over water, pilots should be proficient at reading "windstreaks" in the water. Over land, however, such cues are absent and only pilot reflexes, skills, and experience can be used to avoid problems with takeoffs and landings.

Extreme weather conditions are possible any month of the year in some of the wilderness areas in the northern Rocky Mountains, and, after Labor Day, become problematic on any given day. The Absaroka-Beartooth Wilderness Area, for example, has treacherous winds at its higher elevations beginning yearly around the first of September (G. Schaller, Beartooth District, Custer National Forest, Red Lodge, Montana, personal communication to C. Petrich, Dec. 12, 1984). In the past 11 years, two helicopters have crashed in the Beartooth Mountains during this time of year. Early morning operations minimize the dangers of the hazardous winds. Radio communications between helicopters and between the helicopter and the ground can also be difficult in such terrain. Disciplined radio check-ins and use of the FS chain of repeaters and crystals will be necessary for optimal safety preparation. In such terrain the mountain lakes are often perched or cirque-type lakes; this means they frequently have only one access and egress direction. The difficulties of gaining altitude when the pilots may not be able to take advantage of taking off into the wind can be surmounted only with helicopters having ample power (e.g., the Aerospatiale Lama).

The U.S. Department of the Interior's Office of Air Services in Boise, Idaho, would train both pilots and EPA sampling crews in safety measures to be followed for both the sampling and the air safety portions of the program. Such training would encompass wilderness survival skills.

As a precaution to the helicopter pilot and crew and as a courtesy to all wilderness users, a possible mitigation measure that could be considered would be to have each helicopter be identifiable from each side and from below as being in use by the EPA. Such a designation might avoid misunderstanding as to purposes and diminish any hostile feelings. Shooting threats have occurred with helicopters in use in wilderness areas in the past, and an actual incident occurred during the eastern lake survey outside a wilderness area. Of course, such markings should be part of a larger EPA/FS user education and awareness program for the lake sampling to minimize adverse reactions to the presence of helicpoters and enhance understanding of wilderness management practices.

Recreation

Noise. The main actions that could be taken to reduce helicopter noise impacts on recreationists in the wilderness areas involve employing elements of the "Fly Neighborly" program and sensitive preflight planning with the FS. As mentioned in Sect. 4.1.2, the FAA's advisories regarding the applicability of the "Fly Neighborly" program in extremely quiet areas needs to be remembered. For most helicopters of the type likely to be used in Alternative 1, the noise generated while idling on the water during the sampling process could be reduced by an average of 10 dB_A relative to the flight idle (100% RPM) operation by using the ground idle (67% RPM) mode of operation. This assumes that engine cooling requirements and ability to maintain station will allow such a reduction.

Although shutting off the engine would be the ideal noise reduction strategy, safety concerns arise about the potential for failure to be able to restart the engine, and this action is not recommended.

Another aspect of the "Fly Neighborly" program that would be applicable is the orientation of the helicopter while on the water surface. Each manufacturer has information on the angle of least intense noise propagation coming from each model of helicopter. This is frequently the nose of the helicopter. Positioning the nose (or its low acoustical energy equivalent) toward the most sensitive camping areas, trails, fishing areas, etc., is the recommended action while maintaining the desired location for the sampling crew to do its work. Reductions of 6 to 10 dB_A are possible through use of this simple technique. Water acts as a hard surface to noise, reflecting its energy considerable distances compared to noise propogated over trees or grass where a 4 dB_A reduction would typically be achievable.

Reductions of 3 to 5 dB_A would be possible through using the manufacturer's "Fly Neighborly" cruising speed for all flying over any wilderness territory. Techniques for planning flight paths similar to those used by airport planners in locating approach corridors should be employed to decrease the noise impacts to recreationists (Schomer and Homans 1976). As an example, the FS could provide graphic data or rough estimates of trail and campsite usage such as those in Fig. 4.1-2 for each wilderness area for the time of year in question. Flight paths that avoid critical use areas could greatly reduce the noise (and visual) impact of Alternative 1. This mitigation measure would provide for the least impact to the most wilderness visitors. It would work against those visitors who have specifically sought solitude on the less traveled trails and camping areas. These are just the people who may be most sensitive to any intrusion at all in the wilderness. The proposed helicopter use itself, by being scheduled in the fall, may cause more of a sense of intrusion to all wilderness visitors who wish to go to the area, and perhaps particularly to the more popular areas, in the off-season when more solitude is expected. EPA might require the contractor to use a 4-bladed main rotor helicopter. This would make no difference in the actual dB_A noise level, but the noise is of a type that is perceived to be less of an annoyance in that it reduces the familiar "blade slap" sound.

Most helicopter pilots follow landmarks such as rivers while navigating. This would not be the best plan in wilderness areas because trails and campsites also follow water courses. Flightpaths located on the other side of ridges from heavily used trails could reduce noise considerably. Thus, it would be necessary to define appropriate flight corridors in advance. Through proper planning, crisscrossing of the wilderness should be able to be avoided. Corridors should be designed and agreed to in three dimensions, not merely two. Pilots should be requested to fly higher (2000 ft above terrain) over wilderness territory than they normally would choose. The FAA recommends 2000 ft as the minimum altitude for flying over populated areas (FAA Advisory Circular 91-368). Transition points, where changes from ascent or descent to level flight occur, can be discussed in advance, with the understanding that local wind and weather conditions will have an impact on the pilot's decisions regarding these objectives. To the extent that air photographs could be used to gather site information about each lake, flight time over each lake could be reduced.

Hiking and horseback riding. The scheduling of the proposed helicopter flights only during weekdays would eliminate conflicts with many recreationists of all types who seek short, weekend wilderness experiences. Dominant wilderness use occurs on weekends, and, judging from data on the Desolation Wilderness, the weekend peaks are more pronounced (although of a lower magnitude) in the fall (Hendee et al. 1978). In wildernesses more remote from population centers, such fall weekend peaks may be less pronounced. In wildernesses noted for their hunting, summer use still clearly predominates over fall visitation.

It should be noted that the impacts on some wilderness visitors who have specifically waited until the "off-season" weekday in order to gain more solitude for their experience would be greater than impacts on the more "casual" wilderness recreationist who visits during the more popular periods.

Hunting. The EPA should coordinate their helicopter visitation plans with the FS and state game or wildlife agencies so as to try to avoid conflicts with general or special hunting seasons (e.g., avoiding opening days of hunting season which are especially critical). Some states do not set these dates until spring, so making specific suggestion here is not possible. Bighorn seasons in the Wind River (Wyoming) and Beartooth (Montana) mountains have been identified as being particularly sensitive areas.

The comments on planning the helicopter flightpaths in three dimensions to avoid the more popular trails and campsites also may apply to the avoidance of critical wildlife trails. Again, coordination with the FS and state game agencies should provide the necessary advice.

4.1.7 Consequences to the Survey Objectives

Consequences of any of the alternatives to the NSWS are of environmental significance if they positively or negatively affect the ability of the EPA to formulate an appropriate policy to control acidic deposition, and, indirectly, the impacts attributable thereto. At this time it is not possible to predict what, if any, level of control will be appropriate. However, it is relevant that the NSWS management team has received input from the EPA staff charged with assessing the acidic deposition situation concerning what hypotheses should be verifiable with NSWS data; these hypotheses are central to an understanding of the acidification phenomenon (Bennett 1985).

In this section and in Sects. 4.2.7, 4.3.7, and 4.4.6, the EA examines the ability of the NSWS to provide relevant and adequate data to the EPA assessment staff under each alternative; the presumption is made that this ability is directly pertinent to the ability of the Agency to formulate appropriate policy. Alternative 1 in this EA is identical to the survey protocol used successfully in the East and Midwest in 1984. In the East and Midwest, most of the lakes to be sampled were in fact sampled; specified holding times between sampling and processing/analysis were met. Analysis of the survey data from the East and Midwest is now under way.

The proposed survey is aimed at developing an understanding of the threats to various regions in the country of which the present wilderness system is a sensitive barometer for the West; the approach being used is not appropriate for understanding any one individual wilderness area. That a threat of uncertain dimension and time frame exists to an entire system of 88.6 million acres should in no way make Alternative 1 less deserving of consideration for an exclusion by those responsible for administering a National Wilderness Preservation System than would a specific threat to a specific area (Sect. 3.1.2).

The proposed NSWS survey is designed to collect data to help develop understanding and policies that can be used to minimize or eliminate the damages that are, or could occur, due to acidic deposition on natural systems. A long-term benefit to wilderness (and other) areas should be the outcome (Fig. 4.1-1). With the principal goal of wilderness preservation being the maintenance (and, if need be, the restoration) of long-term ecological processes (Hendee et al. 1978, Zaslowsky 1984), there is little conflict between the final objectives of the proposed survey and wilderness policies. That acidic deposition could interfere drastically with ecological processes -- or, in the language of the Wilderness Act, "trammel" those processes -- is becoming clear from some studies of the high mountain west (Sect. 1.2) and other locations across the country and in Europe. Wilderness values of all types are threatened when one can observe the types of damage possibly attributable to acidic deposition in the forests around Mt. Mitchell in North Carolina or in New York's Adirondack Mountains.

Under the provisions of the Clean Air Act (42 USC 1857 et seq.), federal land managers of Class I areas (i.e., wilderness areas and national parks) have the responsibility to protect AQRVs threatened by new sources or modifications to existing sources. Those AQRVs identified by the FS include visibility, flora, fauna, soils, and water quality (Haddow 1984). Effects considered might be direct and immediate or indirect and long-term, as in the case of acidic deposition. Effects identified by the FS include changes in pH, total alkalinity, and metal and other ion concentrations of surface water; and changes in growth, mortality, reproduction and productivity of flora and fauna (Haddow 1984). The FS and other land managers will identify adverse effects of new and modified air pollution sources on wilderness areas by comparing measured or predicted changes with levels of acceptable change (LAC). The LACs for the various effects have not been identified because pollution data are lacking for wilderness areas (Haddow 1984). The information from the Phase I survey of the NSWS on susceptibility of lakes to acidification will help to remedy this deficiency.

The use of randomization at some point in the selection schema (i.e., withi strata in the present case) is of paramount importance to the statistical validit of the results. Random sampling at some level is the only way to obtain a valid, model-free probability sample from which valid regional estimates can be obtained.

The choice of sample size is of major importance in the success of the survey. A full evaluation of the consequences of taking 50 samples per stratum cannot be given here, but qualitative assessment of these consequences can be outlined. In assessing sample size, two questions may be asked: is the sample larger than needed to achieve the objectives, or is the sample so small that the results will be of little use? In the present case, the first question is highly unlikely, but the second may be of great concern. The answer can be sought only by dealing with the first objective of the survey; namely, what proportion or percentage of lakes in an area (region, subregion, or stratum) can be classified in some particular manner (e.g., sensitive to acidification, currently acidified, or low alkalinity, pH, or high aluminum, etc.)? For simplicity, the discussion is confined for the moment to the level of individual strata. Also, the criteria for determining the categories (i.e., low alkalinity, sensitivity, acidification, and so forth) are not necessary to examine the question of sample size. Additional details on the material presented here can be found in many statistical texts. Cochran (1977) gives a particularly useful and thorough treatment in a book devoted primarily to survey statistics.

In answering the question posed above by the primary survey objective, the sample lakes will be classified in one of two categories, either positive (sensitive, acidified, etc.) or not. Hence, the results can be expressed in terms of binomial proportions. Confidence intervals for estimates of "how many in a category" are widest when the proportion in the category of interest is 0.5 (50%). Therefore, even though we may not know what proportion to expect, by using 50% we can derive a worst-case (conservative) estimate; all other combinations produce more narrow confidence intervals. Use of binomial theory shows that, in this case, and for a sample size of 50, one could be 95% certain that the one-sided confidence interval (either upper or lower) will not exceed 0.12 (12%).

Because strata are already based on assumptions about alkalinity, acidity, etc., it is unlikely that the actual or estimated proportions will be 0.5, except perhaps in alkalinity class (stratum) 2. That is, in class 1 (low alkalinity lakes), probably most, 0.8 (80%) for example, would be sensitive. In this case, confidence limits approach ±0.10 (10%) of the mean. Such a value is reasonable for field surveys of this sort.

With simple random sampling, this analysis could be extended to estimates for the subregion or region. With the stratified sampling plan, however, the precision of a regional estimate may be greater than with simple random sampling. If the actual characteristics of the lakes within strata, in terms of alkalinity, pH, etc., are in fact highly correlated with the characteristics on which stratification was based, then the proportions of lakes within the categories of interest are likely to be highly separated; e.g., in class 1, 80% sensitive, in class 2, 50% sensitive; and in class 3, 20% sensitive. Under these or similar circumstances, it is likely that the confidence interval for regional estimates will be somewhat reduced. For estimates that combine strata, the increase in sample size will automatically increase precision. For example, combining four strata would halve the one-sided confidence interval. Thus, the sample size appears reasonable for making estimates of proportions both for strata and for regions.

Finally, the NSWS QA approach has been defined, documented and implemented in the NSWS to obtain the best possible data to support the survey objectives (Sect. 2.1.4). The utility of the approach has already been demonstrated in the eastern and midwestern portions of the survey. Any changes in design are likely to affect the validity and integrity of data collected and open them to question and possible challenge.

4.1.8 Cumulative Impacts

There will be no cumulative impacts to wilderness areas from other phases of the NSWS because these activities will not involve the use of helicopters and lakes outside wilderness areas will, where possible, be selected. In terms of cumulative impacts to wilderness areas from future proposals to use helicopters by other researchers or organizations, this alternative could be considered a precedent for authorizing helicopter use for temporary environmental sampling in wilderness areas. What would characterize the proposed use of helicopters as a perhaps unique exclusion is that no individual wilderness area is identified as being specifically threatened, but a definite threat (acidic deposition affecting forest and aquatic ecosystems) of uncertain magnitude and timeframe exists to the entire National Wilderness Preservation System. The rationale for any subsequent authorizations would need to include the concept of the sampling being carried out as a response to a general threat to the long term, enduring wilderness character of the system rather than to any particular area. As such, the precedent established with authorization of the proposed alternative should be readily differentiated from other requests for helicopter use in environmental monitoring requests which, while perhaps dependent on a wilderness environment, seek only relief from problems of efficiency, convenience, or economy. The best way to manage actions to avoid the connotation of "precedence" would be to have all decisions be visibly derivable from policy. The FS manual (USDA undated) has established policies that permit the use of helicopters under stated criteria. A reasonable argument could be made that Alternative 1 is consistent with those criteria and, therefore, neither establishes or contributes to any sense of precedence.

4.2 ALTERNATIVE 2 (USE OF GROUND ACCESS ONLY)

4.2.1 Impacts to Wilderness Values

Wilderness values would be minimally affected by conducting the survey through this alternative. If less-than-adequate data were collected, to the extent that such information impeded the scientific interpretation of the results, the long-term wilderness character could possibly be negatively affected. Choosing to make national air quality decisions without sufficient, sufficiently accurate, or sufficiently representative data could allow more, or more rapid, acidic deposition impacts on given wilderness areas, the general wilderness system, and/or areas outside of wildernesses throughout the country.

Interaction of the survey crews (estimated to be 60 teams of at least 4 people) with other wilderness visitors (total number cannot be estimated without a detailed evaluation of data on each wilderness area) may enhance the public understanding of wilderness management problems and threats to enduring wilderness characteristics due to off-site human actions. Some wilderness visitors, on the other hand, could be repulsed to be in the wilderness and have to deal, however briefly, with people trying to correct civilization's problems -- that may be part of what they went to the wilderness to escape. Observing an adjacent party fishing at a lake can be much less distracting than observing several people unloading a raft, rowing to the middle of a lake, busying themselves with strange-looking scientific equipment, and then returning and preparing preserved samples before packing up horses and leaving. To some visitors these actions may arouse a healthy curiosity; to others they may simply be an annoyance to their solitude and tranquility. Hammitt (1982) found that the "most important dimension of wilderness solitude to users involves being in a natural environment that is removed from manmade intrusions and thereby offers a sense of tranquility and peacefulness."

Using Fig. 4.1-1 to portray the long-term vs short-term impacts to wilderness values under this alternative, Zone "A" would now be lower on the diagram than with Alternative 1. There would still be some close proximity to the limit of acceptable change due to the helicopter activity being focused immediately outside the wilderness area boundaries (Sect 4.2.2) and the large number of survey crews on the trails.

4.2.2 Impacts to Recreation

Sole use of ground-access surveying techniques would increase trail and campsite use during a time of year when wilderness visitors might reasonably expect more solitude and tranquility. The size of each pack train and number of crew members needed on each team would generally be compatible with the size of other parties visiting wildernesses. Wilderness visitors could be negatively affected by the survey crew camping near them at lakes, but presumably no more so than by other ordinary visitors. Hammitt (1982) and Hendee et al. (1978) report that privacy from persons in other parties, particularly large parties, camping in the same general area is an important and highly desired attribute of the wilderness experience for many visitors.

Taking pack horses into the wilderness areas is, of course, a common means of wilderness travel. Some visitors object to the damage pack trains cause to trails: trampling and feeding on surrounding vegetation, introducing seeds of domestic feed grains, fouling the trail with their wastes, expanding the trail width, increasing the trail's depth and erosion potential, increasing soil compaction in tethering areas, and creating the need for sawing through fallen timbers that may otherwise be stepped over or avoided. Hendee et al. (1978) reported that wilderness visitors can better tolerate higher use densities when the contacts involve hikers rather than horse users. Additional physical damage would occur in places where the survey crew would need to gain access to lakes where no trail exists. The survey crew and its pack train would create a temporary new disturbance to the landscape; recovery rates in alpine environments would be difficult to estimate.

Because of generally reduced visitation by most wilderness users (except hunters) in the fall, conflicts between the EPA sampling crews and other wilderness visitors for backcountry permits would be limited. In those wilderness areas where hunting season would be under way, the potential for conflict would exist.

Under this alternative, helicopter activity would be concentrated at landing sites immediately outside the wilderness area boundaries where samples would be brought by riders. While awaiting the arrival of riders, the pilots would be likely to leave their engines in a ground idle mode. The duration of this wait is difficult to predict as it would be dependent on the ability of the riders and pilots to communicate and coordinate pick-up times. In most circumstances, the helicopter engine would be audible for some distance into the wilderness area. This "audibility footprint" would, to a large extent, encompass the periphery of the wilderness area where at least some trails are present. Because most wilderness area users do not take trips longer than two to three days in duration, it is conceivable that the Alternative 2 action might impact more numbers of wilderness visitors (especially those who rarely travel farther than five to seven miles from the boundaries) than the Alternative 1 action would. The remote area wilderness visitor would be less likely to be affected by Alternative 2 except at the beginning or end of a trip. As noted in Sect. 4.1, disturbances at the end of a trip could be most disruptive of all wilderness intrusions.

4.2.3 Impacts to Wildlife and Endangered Species

Wildlife

Under this alternative, the effects of noise on wildlife considered in Sect. 4.1.3 would be eliminated. Although the possibility of human contact with wildlife would increase, its nature would be no different from that already occurring. Thus, no significant impacts to wildlife would be likely under this alternative.

Endangered and Threatened Species

As with other wildlife, adverse impacts under this alternative would be negligible. Proper coordination with local wildlife officials will ensure that survey teams are aware of potential interactions with endangered species and of the proper responses to take in the event of an encounter (Sect. 4.2.7).

4.2.4 Impacts to Water Bodies

Given that sampling of lakes under this alternative would be accomplished from an inflatable boat, rather than a helicopter, no impacts on water bodies would be expected. Any chemical reagents or standards needed in the field could be left on land, rather than carried in the boat. Any overnight stays would be carried out in a manner protective of sanitation, to minimize possible water pollution (see Sect. 4.2.6 for discussion of mitigation measures).

4.2.5 Impacts to Human Safety

This alternative involves having many people sampling high-altitude lakes during the fall when weather conditions are very uncertain. Sampling teams could be isolated by early fall blizzards and be subjected to severe weather conditions. The sampling of extremely cold, alpine lakes through use of inflatable rafts would be dangerous. Leaks or punctures due to snags, rocks, or ice could cause the survey crew to have to swim to shore. In extremely cold lakes, the human body can tolerate less than ten-minutes' immersion before severe hypothermia conditions interfere with judgment and physical performance. An accident in the middle of a large lake could, therefore, cause serious problems. Handling some of the reagents used in the chemical analyses in a non-laboratory environment would create some hazards to the survey crew.

Accidents involving horses being ridden or led through rocky, mountainous terrain are not common, but a possibility. The use of experienced wranglers and guides would presumably minimize the likelihood of any problems.

4.2.6 Mitigation Measures

Plans for developing site-specific migitation measures would be similar to those described for Alternative 1 (Sect. 4.1.6). Stock animals need to be properly cared for and tethered at campsites. The pack train leader and FS would be familiar with site-specific regulations. Feed might have to be packed in for some sampling destinations, and pack animals kept some distance from the camp. The survey crew would need to select sites (1) in an area with few, or no, other camp sites and (2) as far as possible from other visitors. Keeping quiet and using the most appropriate wilderness camping etiquette would also be appropriate in these areas.

For safety reasons, life preservers and wet suits would be needed for use in the lake sampling operation. Clothing for rapidly warming a hypothermia victim should be available.

Only experienced packers with local knowledge should be used, and FS recommendations should be solicited. Forest Service officials should attempt to adjust their permit policies for backcountry users, or possibly consider EPA crews as a separate category of users, so that (1) the crews are not in the wilderness areas during hunting season, or (2) if present, the crews do not compete for permits normally available to other users.

Riders and helicopter pilots should carry radios to coordinate their rendezvous time. Effective coordination would minimize helicopter noise in the vicinity of the landing site.

4.2.7 Consequences to the Survey Objectives

The introduction to Sect. 4.1.7 explained the rationale linking the NSWS to the formulation of appropriate policy by EPA to control acidic deposition and the impacts thereof. If an alternative method of conducting the survey could positively or negatively affect the quality of the survey results, then an environmental impact may tentatively be attributed to the alternative. This section examines four aspects of Alternative 2 that could have a bearing on the quality of the Survey results:

1. Would the sample design be changed? That is, would there be a bias in the data such that the survey could not be used to characterize with a known statistical confidence conditions in areas of concern in the United States?

2. Would changes in sampling and analytical methods, or deletions of certain variables, fail to provide data, or provide data of insufficient precision or accuracy, increasing probability that the survey would not meet the needs of the EPA assessment staff?

3. Given that the NSWS involves coordination of a major scientific undertaking with logistical challenges - e.g., a large staff spread out over many hundreds of miles all attempting to follow strict protocols; unpredictable weather conditions; sometimes temperamental equipment - would an alternative increase the

probability of failure of the NSWS? Would deadlines not be met, protocols not be followed, equipment not function, lakes not be sampled?

4. Would an alternative result in some lakes that physically could not be reached - no trails over which equipment could be carried, or terrain requiring technical climbing skills?

Sampling Design

The proposed sample design for this alternative would be identical to that for Alternative 1. However, logistic difficulties discussed below make it likely that fewer lakes than intended in wilderness areas would be sampled. Although the number of lakes that could not be reached is unknown at this stage in planning, information on a few wilderness areas suggests that as many as 20% of the selected lakes could be eliminated from the sample. Such failures would introduce additional errors into the sample estimates, termed noncoverage by Cochran (1977). If all or some of the noncovered items (inaccessible lakes in this case) have certain common features (e.g., low alkalinity), then bias will be introduced into the sample estimates. Once again, consideration of this aspect is most simply approached through consideration of proportions (Sect. 4.1.7, objective 1 of the survey). Again also, a rigorous treatment is precluded here but some indications are possible. Cochran (1977) illustrates how to calculate conservative confidence limits when the degree of nonconverage is known only from the sample and when the characteristics of the noncovered units are unknown. Applying the method to a series of hypothetical lakes in a stratum (e.g., class 1 lakes, 5 of those which are in wilderness are lost due to inaccessibility, and 80% of sample lakes prove to be sensitive by established criteria) suggests that, if more than about 10 lakes per stratum were lost due to inaccessibility, confidence limits would increase to more than 0.50 (50%) of the mean. It is possible, of course, that the limits would in fact turn out to be less, but there is no objective way to judge in advance. Similarly, results given by Birnbaum and Sirken (1950) suggest that, to maintain 95% confidence limits at ±12% of the mean at a sample size of 50 would permit only 2 lakes per stratum to be inaccessible.

The situation worsens when it comes to describing distributions and comparing their properties. With continuous data, any sizable proportion of noncoverage (e.g., 15%) usually makes it impossible to assign useful confidence limits to the mean from sample results. "We are left in the position of relying on some guess about the size of the bias, without data to substantiate the guess" (Cochran 1977).

As a result of these and related considerations, EPA would not sample a stratum if it knew in advance that fewer than 40 samples could be taken (D. Brakke, Western Washington University, personal communication to J. W. Webb, ORNL, Feb. 1, 1985). If, for some reason, fewer than 50 lakes were sampled without previous knowledge, EPA would lump samples across strata or take other action to improve the statistical reliability of the estimates before undertaking statistical analysis.

In the western pilot study, only 38 lakes could be sampled by horseback, out of an intended 50, as a result of logistic difficulties associated with horse travel (see further discussion under "Logistics" below). With the narrow time frame and unpredictability of the weather, similar problems could easily occur during the proposed survey. Any failure to sample selected lakes in wilderness would decrease the size and randomness of the sample as described above.

Sampling and Chemical Analysis

If access to the lakes is via horseback rather than via helicopter, most water-quality variables would have to be sampled and analyzed using different protocols that are untested in terms of meeting the NSWS DQO's. Modifications to the proposed methods were described in Sect. 2.2.3. The following discussion addresses the programmatic implications of such modifications.

Sampling via horseback rather than via helicopter would rule out obtaining low-elevation aerial photographs of the sampled lakes at the time of sampling (Sect. 2.2.2). If there were any subsequent confusion over which lakes had been sampled, it would not be possible to resolve this by consulting aerial photographs; this could represent a quality-assurance problem of unknown significance.

If the filtration and MIBK aluminum extraction is done in the field, rather than at the field base laboratory, there would be analytical and logistical advantages and disadvantages. This modification would involve certain risks (the reagents can not be allowed to freeze; filtration pressure can not be as well controlled as in the field base laboratory; filtration time might be lengthy in some cases; control over hazardous reagents such as 8-hydroxyquinoline and MIBK would be less in the field than in the laboratory setting; there is an increased chance of contamination (e.g., from dust) given less-than-ideal field conditions relative to those found in a field base laboratory). Also, as the extraction procedure involves pH adjustment (Sect. 2.1.3), field extraction would also require that pH be measured in the field using portable equipment, the difficulty of which is described below. However, in comparison to the relatively short holding time (4-6 h between collection and extraction) specified by the NSWS protocol, the sample, once extracted into the MIBK, could be refrigerated for up to six months without significant degradation [C. Driscoll, Syracuse University, New York, personal communication with R. Cushman, ORNL, Dec. 10, 1984], although the NSWS protocol calls for analysis within seven days because loss of the volatile MIBK from the extracted sample could result in an erroneously high concentration as measured (E. Meier, EPA, Las Vegas, personal communication with R. Cushman, ORNL, Jan. 14, 1985). Extraction immediately (within 1-2 h) following collection would be preferable to the existing NSWS protocol (which calls for extraction within 4-6 h and in practice is completed within 12 h) in terms of minimizing sample degradation before processing (Sect. 2.1.3 for a discussion of sample degradation in aluminum determinations). The overall quantitative effect of this modification has not yet been defined.

Aluminum extractions other than in a controlled laboratory setting have been proposed and used by other researchers. The provisional protocol of the EPA Program for Long-Term Monitoring of Surface Waters in the United States (Powers and Allum 1984) originally recommended filtering and extracting aluminum samples in the field, although the NSWS procedures described in

Sect. 2.1.3 are now expected to be used for the Long-Term Monitoring portion of the NSWS (USEPA 1984a; D. Brakke, Western Washington Univ., personal communication with R. Cushman, ORNL, Feb. 14, 1985). Field extractions for aluminum have been performed by the USGS for several years (O. Bricker, USGS, Reston, Virginia, personal communication with R. Cushman, ORNL, Dec. 11, 1984; and V. Kennedy, USGS, Menlo Park, California, Dec. 17, 1984). However, the field conditions encountered by previous researchers have probably not been as severe as those likely to be faced by the NSWS sampling teams (e.g., severe weather, access by horseback, severe time constraints, lack of shelter).

Kennedy et al. (1974) compared "field" (in a motel room) and laboratory extractions (filtered) of aluminum, working with concentrations of from 1 to 13 ug/L. They found that the coefficient of variation of aluminum concentration was 10% with the "field" extractions and 13% with the laboratory extractions. The "field" conditions of Kennedy et al. were probably intermediate between the lakeside and field base laboratory conditions, but these results suggest that precision might not necessarily suffer if the NSWS lake samples were filtered and extracted in the field (rather than in a field base laboratory), without access to a laminar flow hood. However, it is not possible to answer all concerns related to sample contamination and accuracy of the data at this time. If precise, accurate measurements of monomeric aluminum are not available, the NSWS would fail to provide data on what is now seen as an important aspect of lake acidification.

If the filtration and MIBK extraction for aluminum is done in the field and the sample refrigerated, the necessity of immediate delivery to the field lab of the sample for extractable aluminum determination would be lessened. Nevertheless, the need for prompt analysis of pH and DIC would remain. Two standard references, Methods for Chemical Analysis of Water and Wastes (USEPA 1983), and Standard Methods (APHA, AWWA, and WPCF 1980), recommend that sample pH be measured "as soon as possible" and "immediately." The syringe sample, refrigerated and isolated from the atmosphere, is analyzed at the field lab within 12 h under the first alternative (Sect. 2.1.3). Although the cold storage temperature and isolation from the atmosphere of the syringe samples will minimize sample deterioration (discussed in Sect. 2.1.3), any further delay could jeopardize the accuracy of the pH and DIC data.

Jeopardizing the accuracy of the pH determination at the field base laboratory could require increased reliance on the field analysis to assess in-situ lake pH. A number of researchers (Galloway et al. 1979, Koch and Marinenko 1983, McQuaker et al. 1983, Turk 1984b) have noted the difficulties of measuring the pH in dilute waters. Turk (1984a) estimated precision of pH measurements of three dilute lakes in the Flat Tops Wilderness Area, Colorado, using battery-operated pH meters transported by horseback, similar to the alternative sampling method proposed in Sect. 2.2. He found that the standard deviation of pH measurements was 0.07 units. Turk (1984b) also estimated the potential accuracy possible with field equipment by comparing calculated pH of known solutions with pH determined in the laboratory with field equipment; measurement error (mean of 12 and 34 measurements) was 0.05 and less than 0.01 units, respectively, for the two known solutions. However, the accuracy and precision achieved by Turk required a rather lengthy procedure to eliminate cross-contamination and maximize equilibration; it is unlikely that this procedure would be consistent with the time constraints of the NSWS. An EPA report

(USEPA 1984g, p. 4-56) indicates that accuracy and precision of field pH measurements may be at best ± 0.05 units, compared with ± 0.02 units for laboratory measurements. McQuaker et al. (1983) concluded that accuracy of field measurements of pH in dilute waters was unlikely to be better than 0.1-0.2 units, an order of magnitude worse than is possible in a laboratory. Thus, it is difficult to predict the accuracy or precision of pH measurements possible under field conditions, but there is evidence that routine measurements in the field would not be as precise or accurate as measurements at the field base laboratory. Furthermore, because pH measurements in the field could not be accompanied by a simultaneous DIC determination, it would not be possible to quality assure the data using the pH-DIC-alkalinity check described in Sect. 2.1.3.

In summary, modifications to the proposed sampling and analytical procedures for extractable aluminum, DIC, and pH are possible. It is not possible to predict quantitatively the effect on the precision and accuracy of the data, but it is likely that the quality of the data would suffer. Without the simultaneous DIC determination, the NSWS researchers would be unable to assess the accuracy of the pH data.

Several factors would tend to make sampling and analysis more difficult under this alternative than under the helicopter-access alternative. First, calibration of the Hydrolabs (performed immediately before and after the helicopter trip under the first alternative) would be a problem in the field, in terms of freshness of standard solutions and/or time interval between calibration and field measurement; transporting CO_2 cylinders by horseback into the wilderness areas would be required for pH calibration. Second, obtaining data of maximum precision and accuracy from field equipment under conditions more difficult than those found in the field base laboratories (e.g., poor lighting, extremes in temperature and humidity) would be a challenge to the survey personnel. For example, Turk (1984b) noted the difficulty of measuring pH under extreme weather conditions; moisture in the electrode connections was cited as a particular concern. Similarly, the western pilot study (USEPA 1984f) demonstrated the problems with attempting precise sampling and analytical work given severe weather and inadequate shelter and lighting. Third, the threat of sample contamination would always be a problem in the field. Fourth, sample degradation is a threat to data quality, and while measures would be employed to preserve samples (refrigeration, isolation from the atmosphere), analysis "as soon as possible" is desired, and any deviation from this could adversely affect the survey results. The possible effect of shaking on sample integrity as a result of ground transport is another factor that would need to be evaluated in a comparability study.

Quality assurance

Each alternative to the methods proposed for the NSWS involves a higher degree of risk in terms of data quality, and it cannot be predicted whether the data collected would be satisfactory in terms of precision, accuracy, freedom from contamination, and comparability. If access by ground is required, the EPA would have to examine the issue of changes in data quality by sampling some lakes both by helicopter access and by horseback and comparing the data. Any modifications to the NSWS methodology at this point would introduce the undesirable element of changing methods midway through the study; this is something to avoid in any scientific endeavor, and for the NSWS would jeopardize the ability to make inter-region comparisons.

Sampling via horseback can increase sample exposure to dust and dirt which results in contamination for sodium, aluminum, and other parameters. It is anticipated that this contamination could be as high as 0.5 ppm for sodium and 100-200 ppm for aluminum. Such levels of contamination could eliminate important data from the decision-making process.

If the number of sampling teams or the number of sampling days were increased, the number of field duplicates would have to be increased accordingly. These duplicates are used to estimate overall precision of the sampling and analytical process (Sect. 2.1.4). If Alternative 2 is used, additional duplicate samples will have to be collected to compare precision between the two approaches. If the precision of samples collected via horseback is significantly different from the current schema, the data may not be comparable and may be invalidated for the objectives of the survey. In addition, a more time consuming approach, such as sampling via horseback, would require additional duplicate samples to cover the extended time period.

Any change in the current design and sampling approach for the lake survey would greatly weaken the confidence in the data quality, and some data would be likely to be invalidated as a result of these changes. A change to horseback or ground sampling teams could have a significant impact on the data and might result in lack of adequate, accepatable data to meet the objectives of the western portion of the lake survey. As discussed above, such changes in design can, and probably will, affect the validity and integrity of the QA approach. To summarize, the following QA problems are likely to occur:

1. Data across sampling teams, field base stations, and regions might not be comparable. Thus key objectives of the NSWS might not be achieved.

2. More complicated logistics would be likely to reduce or eliminate the ability of the survey to provide comparable data of acceptable quality.

3. Increased staff requirements would mean more personnel involved in the sampling process and a higher probability that problems would arise that result in data that are not comparable or are of unacceptable quality.

4. Sample contamination would be much more likely to occur and would be likely to result in invalid data and loss of key objectives of the survey.

5. Regardless, additional QA and data management cost would be incurred just to verify that the problems did occur (i.e., additional costs to find out that the data could not be used).

6. There would be a good chance that holding times would be exceeded. Holding times have been established for the NSWS as a whole and need to be met. Anyone opposed to the conclusions of the survey or subsequent regulatory actions could use the established holding times (if they are exceeded) in a court action to challenge data quality.

Logistics

Previous experience. To determine the feasibility of gaining access to lakes by horse or foot, a pilot study to sample 50 lakes in western wilderness areas was undertaken by EPA and the FS during the fall (mid September to mid October) of 1984. Only 38 lakes could be sampled during the three-week study; 12 in the Uintas Wilderness Area, Utah, 20 in the Weminuche Wilderness Area, Colorado, and 6 in the Cloud Peak Wilderness Area, Wyoming.

A major blizzard occurred which closed trails in the Cloud Peak Wilderness Area and caused delays in other areas. Access roads to trailheads were also in poor condition during this time. Equipment transported by pack horses was damaged in some instances; a Hydrolab and Van Dorn sampler were damaged, and a rubber boat was punctured. The sheer bulk of the sampling gear was found to be a burden on the horses, and packing and unpacking the horses was time-consuming.

Problems were encountered with sampling from rubber boats. Weather conditions gave the crews problems in launching the boats, and the presence of thin layers of ice which formed in the shallows caused concern about punctures to the boat and subsequent sinking. Once the samples were collected, preparation of the samples either in a tent or outside was difficult, and the samples were subject to contamination from exposure to the elements. In most cases the holding time requirements of the NSWS were met, but extractable aluminum and DIC were not measured.

Even with careful planning, it was difficult to sample more than one lake per day. On the average, one and a half lakes could be sampled each day, with a maximum number of three. Some lakes are more than a day's ride from a wilderness boundary, and some lakes have no trails to them, making access by horseback impossible. In addition, the sampling design of the pilot study selected lakes which were clustered to minimize travel time among lakes. This approach would not be applicable to the larger survey and more transit time would be needed to reach the lakes involved.

If helicopter access is not possible, then aerial photographs could only be obtained from fixed-wing aircraft flying at least 3000 ft above the areas; these photographs are a QA measure in that they document exactly which lakes have been sampled, in case of later confusion (USEPA 1984d).

Analysis of Feasibility. To assess the feasibility of reaching the selected lakes by horseback, five wilderness areas (one each from five FS regions) were chosen, and local district rangers were contacted. Information was gathered on the distance from trailhead to lake, condition of trail, and expected time required for access. Table 4.2-1 summarizes this information.

Table 4.2-1. Accessibility by horseback to NSWS sample lakes in selected wilderness areas*

Wilderness area	Lake name	Likelihood of getting samples to field lab in 8 h	Comments on accessibility by horseback
Mt. Evans[a] (Colorado)	Chicago Lakes	Probable	2 miles from road
	No name	Probable	0.5 mile from road (no existing trail)
Pasayten[b] (Washington)	Jerry Lakes	Uncertain**	7 miles (last 2 on foot) from trailhead
	Lake of the Pines	Improbable	15 miles (last 2 on foot) from trailhead
	White Lakes	Improbable	21-22 miles from trailhead
	Sheep Lake	Improbable	22 miles from trailhead; also a possible 5-6 h hike on foot to alternate access point in Canada
	Black Lake	Probable	4 miles from trailhead
	Lease Lake	Improbable	21 miles from trailhead (last 5-6 miles may be impassable to stock because of downed timber on abandoned trail)
	No name	Improbable	24.5 miles from trailhead in Canada; 37.5-38.5 miles to trailhead in U.S. (last 3.5 miles on foot)
Bridger (Wyoming)	Crescent Lake	Probable	10 miles from trailhead
	Kevin Lake	Improbable**	11 miles from trailhead, approximately half on foot; poor access by horseback
	Shirley Lake	Probable	approximately 5 miles from trailhead
	Gadsby Lake	Uncertain**	approximately 6 miles from trailhead; last mile on foot

Table 4.2-1. (continued)

Wilderness area	Lake name	Likelihood of getting samples to field lab in 8 h	Comments on accessibility by horseback
Bridger (Wyoming)	Palmer Lake	Probable	7 miles from trailhead
	Borum Lake	Uncertain	12 miles from trailhead
	Bridger Lake	Improbable**	approximately 15 miles from trailhead, mostly on foot; no established trail
	Little Seneca Lake	Uncertain	10 miles from trailhead
	Spider Lake	Uncertain	12 miles from trailhead
	Barnes Lake	Probable	Approximately 7 miles from trailhead
	Cross Lake	Probable	Approximately 13 miles from trailhead
	Valley Lake	Uncertain	17 miles from trailhead
	Full Moon Lake	Uncertain	11 miles from trailhead
	Halls Lake	Improbable	20 miles from trailhead
	Shoestring Lake	Uncertain	0.5 miles from Halls Lake, probably by foot
	Bobs Lake	Probable	11 miles from trailhead
	Upper Silver Lake	Probable	14 miles from trailhead
	Warbonnet Lake	Probable	14 miles from trailhead; last 0.5 mile may be cross-country through meadow

Table 4.2-1. (continued)

Wilderness area	Lake name	Likelihood of getting samples to field lab in 8 h	Comments on accessibility by horseback
	Little Divide Lake	Probable	6 miles from trailhead
	Poston Lake	Uncertain**	1 mile hike from helicopter landing site at edge of wilderness
	Dads Lake	Probable	6 miles from trailhead
	Blue Lake	Probable	7 miles from trailhead; last mile on a sheepherder trail
Ansel Adams[d] (formerly Minarets) California	Kidney Lake	Probable	4-4.5 miles from trailhead; last 0.5 mile on foot or leading pack animals, no trail
	Nydiver Lake (middle)	Probable	8-10 miles from trailhead
	Iceberg Lake	Uncertain**	9.5-12 miles from trailhead; last 1.5-2 miles on foot or leading pack animals
	Walton Lake	Uncertain**	15-16.5 miles from trailhead; last 1-1.5 miles on foot (may be some possibility of leading pack animals)
Absaroka-Beartooth[e] (Montana)	Flat Rock Lake	Uncertain**	12-13 miles from trailhead; last 5-6 miles by foot or leading pack animals
	Elephant	Improbable**	9-9.5 miles from trailhead; last 2-2.5 miles on foot; will require personnel with advanced climbing skills
	Lost Lake	Uncertain**	4 miles on foot or leading pack animals from nearest trail; personnel with advanced climing skills may be needed

Table 4.2-1. (continued)

Wilderness area	Lake name	Likelihood of getting samples to field lab in 8 h	Comments on accessibility by horseback
	Rainbow Lake (3rd from NE)	Probable	9-10 miles from trailhead
	Red Rock Lake (eastern)	Uncertain**	12-13 miles from trailhead; last 4-5 miles on foot or leading pack animals
	Black Canyon Lake	Uncertain**	8 miles from trailhead; last 1.5-2miles on foot or leading pack animals
	Fire Lake	Uncertain**	6-6.5 miles from trailhead; last 1.5-2 miles on foot

* All distances are given from trailhead unless otherwise noted; in some wilderness areas, proximity of lakes to each other may allow sampling of more than one lake on a given trip.

** At least 1 mile of total distance on foot.

[a] Personal communication from Larry Lindener, District Ranger, Mount Evans Wilderness, Idaho Springs, Colorado, to Robert Cushman, Oak Ridge National Laboratory, December 18, 1984.

[b] Letter from Curtis Edwards for Larry Tripp, District Ranger, Okanogan National Forest, Winthrop, Washington, to Robert Cushman, Oak Ridge National Laboratory, December 13, 1984.

[c] Letter from Dean Grover for Sam Warren, District Ranger, Bridger-Teton National Forest, Pinedale, Wyoming, to Carl Petirch, Oak Ridge National Laboratory, December 18, 1984; 11 unnamed lakes to be sampled are not included.

[d] Personnal communications from (1) Butch Jones, District Lands Manager, Minarets Ranger District, Sierra National Forest, North Fork, California, 12/10/84; (2) Mark Harris, Mono Lake Ranger District, Inyo National Forest, Lee Vining, California, 12/17/84; (3) Mark Clark, Mammoth Ranger District, Inyo National Forest, Mammoth, California, 12/17/84; and (4) Ernie DeGraff, Recreation Manager, Inyo National Forest, Bishop, California, 12/11/84, to Carl Petirch, Oak Ridge National Laboratory.

[e] Personnal communications from (1) George Schaller, Resource Assistant, Recreation and Land Staff, Beartooth Ranger District, Custer National Forest, Red Lodge, Montana, 12/12/84; and (2) Chuck Harris, Resource Assistant, Livingston Ranger District, Gallatin National Forest, Livingston, Montana, 12/17/84, to Carl Petrich, Oak Ridge National Laboratory; ten unnamed lakes not included.

For some lakes, it appears relatively easy to return samples to the field base laboratory within 8 h to allow for processing of all samples within the 12 h interval specified in the current NSWS protocol (Sect. 2.1.3), assuming that a helicopter would be available immediately to meet the pack train as it left the wilderness area and would take no more than an hour to transport samples to a field base laboratory; these assumptions have not been assessed and may be optimistic. For a number of lakes, it is questionable whether the delivery criterion could be met. In some cases, two days might be required for delivery of samples to the field base laboratory. This delay would be accommodated by modifying methods (e.g., extracting aluminum and processing all samples in the field). These options are discussed and assessed in Sects. 2.2.3 and 4.2.7. Finally, lakes that would require a long hike on foot (because no trails are present or trails are impassable by horseback) would be impractical to sample under this alternative because the weight and bulk of the gear to be carried is too great, especially at high altitudes.

4.2.8. Cumulative Impacts

No significant cumulative impacts are anticipated from the use of horses to gain access to survey lakes. Use of horses would contribute in a minor way to existing problems of trail erosion, disposal of human waste, and introduction of exotic seed from domestic grain and feed carried into the areas. To the extent that the quality of the final survey results are affected, the comments in Sect. 4.4.8 could be applicable.

4.3 ALTERNATIVE 3 (COMBINED USE OF HELICOPTERS AND GROUND ACCESS)

4.3.1 Impacts to Wilderness Values

Potential impacts under this alternative would be somewhere intermediate between the first two alternatives depending on the relative mix of access modes (helicopter vs horse).

4.3.2 Impacts to Recreation

Potential impacts under this alternative would be somewhere intermediate between the first two alternatives depending on the relative mix of helicopter-sampled vs ground crew-sampled lakes.

4.3.3 Impacts to Wildlife and Endangered Species

Wildlife

Potential impacts to wildlife under this alternative would be intermediate between the previous two. Although some minor impacts might result from aircraft noise, the incidence would be less than with Alternative 1 because many lakes would be sampled by ground crews.

Endangered and Threatened Species

As with other wildlife, adverse impacts under this alternative would be intermediate between the previous two. Significant impacts could be avoided by proper coordination with local wildlife officials (Sect. 4.2.7)

Even though four endangered or threatened fish species [a dace and three trout species (Sect. 3.3)] may be found in or near wilderness areas to be sampled in the NSWS, no adverse effects would be expected except in the unlikely event of a large accidental fuel spill into a small water body containing the species.

4.3.4 Impacts to Water Bodies

Effects on water bodies under this alternative would pertain only to those lakes to be sampled by helicopter (potential for spills or leaks, as described in Sect. 4.1.5) and are likely to be minor. For those lakes where access would be via horseback, the probability of impact is slight (Sect. 4.2.5).

4.3.5 Impacts to Human Safety

Potential impacts under this alternative would be somewhere intermediate between the first two alternatives depending on the relative mix of helicopter-sampled vs ground crew-sampled lakes.

4.3.6 Mitigation Measures and Contingency Plans

In some senses this alternative can be considered a mitigation measure in itself, in that pack horses will be used to minimize intrusion of especially sensitive areas. Elsewhere, mitigation measures described in Sect. 4.1.6 are applicable wherever helicopters are operated within or in close proximity to wilderness areas.

4.3.7 Consequences to the Survey Objectives

The magnitude of programmatic consequences of this alternative would depend on the exact mix of helicopter-access vs horse-access lakes and on the extent to which modifications in the sampling protocols were made. Section 4.2.7 discusses the consequences to survey object of several modifications that would be implemented if access by horse were required. Sampling with two different mechanisms of access creates problems of data comparability, and additional studies would be needed for quality assurance (see discussion in Sect. 4.2.7).

4.3.8 Cumulative Impacts

Cumulative impacts potentially associated with this alternative would be the same as those identified with the use of helicopters alone (Sect. 4.1.8). To the extent that the quality of the final survey results are affected, the comments in Sect. 4.4.8 could be applicable.

4.4 ALTERNATIVE 4 (NO SAMPLING IN WILDERNESS AREAS)

4.4.1 Impacts to Wilderness Values

While there would be no direct, immediate impacts to wilderness values with this alternative, the long-term indirect impacts could be severe (to a given wilderness, to the wilderness system, and/or to the general country outside of wilderness areas) if acidic deposition were to damage forest and/or aquatic ecosystems. Such impact assumes no other actions by government agencies are taken, or are not taken, in a sufficiently timely manner to control acidic deposition.

If wilderness areas were not sampled, the recommendations that could arise from interpreting the final study results may not be sufficiently protective of wilderness ecosystems to ensure protection of wilderness character for generations. In terms of Fig. 4.1-1, zone "A" would not exist, but zone "B", in the location shown, would be more of a certainty.

4.4.2 Impacts to Recreation

Under this alternative there would be no direct impacts to recreationists' wilderness experiences. Indirect impacts due to long-term degradation of wilderness characteristics could mean a diminished fishery resource, fewer and less vigorous game species, and loss of aesthetic quality of the natural setting.

4.4.3 Impacts to Biotic Resources

Because there will be no activities associated with the NSWS survey within wilderness areas under this alternative, there should be no direct, short-term impacts of the survey on human or ecological resources within these areas.

4.4.4 Impacts to Human Safety

There would be no impacts to human safety under this alternative.

4.4.5 Mitigation Measures and Contingency Plans

Because no wilderness areas will be sampled, there is no need for mitigation measures and contingency plans.

4.4.6 Consequences to the Survey Objectives

Because wilderness areas are associated with several characteristics that are themselves associated with sensitivity to acidic deposition and related measures, failure to sample these areas would introduce serious bias into the results. All regional estimates based on the NSWS data base would only be applicable to nonwilderness, and the objective of providing a regional picture of sensitive lakes would thus be compromised. For example, the distribution of selected lakes by alkalinity class (Table 4.4-1) shows that relatively more lakes of low alkalinity (Class 1) occur in wilderness areas. A chi-square test on these values shows that the association of wilderness with low alkalinity class is very unlikely to have occurred on the basis of chance (P is less than 0.005). A sample

Table 4.4-1 Number of lakes selected in and out of wilderness areas, with numbers expected based on chance alone in parentheses (expected)[a]

Status		Alkalinity Class	
	1	2	3
In Wilderness	248 (169)	151 (165)	99 (163)
Out of Wilderness	54 (133)	144 (130)	192 (128)

[a] Chi-Square = 143.7, P less than 0.005.

which excluded wilderness lakes would underestimate the susceptibility of the entire region's lakes to acidification. Similarly, the land use and elevation of wilderness lakes probably have relationships to lake chemistry that would produce biases in the regional picture of acidity and susceptibility if these lakes were excluded. The results of the survey could not validly be extrapolated and used in management and mitigation decisions for wilderness.

It would be possible to attempt to include the characteristics represented by wilderness lakes by subjectively selecting lakes outside wilderness areas that appeared suitable with respect to characteristics of known or suspected importance (e.g., elevation, physical and biotic features, undisturbed nature). Such an approach would violate the statistical validity of the estimates, which requires random selection (Sects. 2.1.1 and 4.1.7). It would be impossible to make inferences about regional characteristics using such data because many of the inferences sought (e.g., how important are bedrock characteristics to lake susceptibility?) would have been used to select the substitute lakes. Because many of the objectives of the survey would be unobtainable, there would be considerable doubt that the results of the survey would justify the expenditure of funds to do it.

4.4.7 Cumulative Impacts

The cumulative impacts associated with not sampling wilderness area lakes could be those associated with the long-term degradation of forest and aquatic ecosystems in wilderness areas (and elsewhere). The understanding of the acidic deposition problem nationally and regionally would be compromised to a significant, though unquantifiable, degree by not having the National Wilderness Preservation System represented in the current NSWS. The uses of wilderness either as an ecological yardstick or barometer or as a site for basic biological research (see Sects. 3.1.1, 3.1.2, and 3.1.3) are intents of the Wilderness Act; not sampling the wilderness area lakes could further the impression held by some that the FS interprets its regulations so rigidly that it discourages even the pursuit of biological research in wilderness area (Drabelle 1984). Following this same line of thinking, some people could use the example created here (i.e., not sampling wilderness lakes) as further evidence that rigid maintenance of short-term wilderness values is shortsighted and not in the best public interest, either for the long or short term. A "purity backlash" (Hendee et al. 1978) regarding a perceived inflexibility in wilderness management practices could evolve, creating uncertain political actions with uncertain associated environmental consequences to wilderness areas.

5. LIST OF PREPARERS

This Environmental Assessment was prepared for the U.S. Environmental Protection Agency, Region 10, Seattle, Washington, by staff in the Environmental Sciences Division and Energy Division of Oak Ridge National Laboratory, Oak Ridge, Tennessee. The following individuals prepared the document:

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Robert M. Reed - Ph.D. (Plant Ecology)

> Eight years' experience in university research and teaching; ten years' experience in environmental impact research and analysis; coordinated preparation of general sections and served as project manager.

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6. PUBLIC INVOLVEMENT

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U. S. Environmental Protection Agency

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Environmental Monitoring Systems Laboratory, Las Vegas, NV
Environmental Research Laboratory, Corvallis, OR
Office of Federal Activities, Washington, D. C.
Regional Offices, Denver, CO and San Francisco, CA
Office of Research and Development, Washington, D. C.
Idaho Operations Office, Boise, ID
Oregon Operations Office, Portland, OR
Washington Operations Office, Olympia, WA

U. S. Department of Agriculture

Forest Service - San Francisco, CA; Denver, CO; Jackson, WY;
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  Watershed and Air Management, Washington, D. C.
Soil Conservation Service, Davis, CA and Salt Lake City, UT
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U. S. Department of the Interior

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  Water Resources Branch, Ft. Collins, CO
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      Yosemite NP, Yosemite NP, CA
      Lassen Volcanic NP, Mineral, CA
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      North Cascades NP, Sedro Woolley, WA
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Billings, MT
Fish and Wildlife Service - Sacramento, CA; Billings, MT; Boise, ID;
Salt Lake City, UT; Helena, MT; Reno, NV;
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Endangered Species Division - Sacramento, CA; Boise, ID;
Helena, MT; Salt Lake City, UT
Animal Damage Control Division - San Francisco, CA and Reno, NV
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Bureau of Reclamation - Boulder, CO; Sacramento, CA; Boulder City, NV
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U. S. Department of Commerce

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California

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Department of Forestry, Sacramento
Office of Planning and Research, Sacramento
Environmental Affairs, Sacramento
Department of Fish and Game, Sacramento
State Forester, Sacramento
Resources Agency, Sacramento
Air Resources Board, Sacramento
Water Resources Control Board, Sacramento
Office of Planning and Research, Sacramento

Utah

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Executive Assistant to Governor, Salt Lake City
Department of Natural Resources and Energy, Salt Lake City
State Planning Office, Salt Lake City
Division of Wildlife, Salt Lake City
Outdoor Recreation Agency, Salt Lake City
Department of Natural Resources, Salt Lake City

Bureau of Land Management, Salt Lake City
Bureau of Water Pollution Control, Salt Lake City
Division of State Lands and Forester, Salt Lake City
Division of Wildlife Resources, Salt Lake City
Office of Planning and Budget, Salt Lake City

Colorado

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State Engineer, Denver
Department of Natural Resources, Denver
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Outfitters Certification Board, Moffat
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Oregon

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State Forester, Salem
Department of Fish and Wildlife, Portland
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Department of Environmental Quality, Salem

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Bureau of State Planning and Community Affairs, Boise
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- Department of Conservation and Natural Resources, Carson City
- State Conservation Commission, Carson City
- Department of Wildlife, Reno
- Division of Environmental Protection, Carson City
- Division of Water Resources, Carson City
- State Office of Community Services, Carson City

Washington

- Governor of Washington, Olympia
- Department of Natural Resources, Olympia
- Department of Ecology, Olympia
- Department of Game, Olympia
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- Department of Fisheries, Olympia

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- State Engineer, Cheyenne
- Water Research Center, Laramie
- State Clearinghouse, Cheyenne
- Recreation Commission, Cheyenne
- Wyoming State Legislator, John Turner, Moose

Arizona

- Commission on Arizona Environment, Phoenix

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Public Works Department, Denver, CO

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Izaak Walton League of America, Inc. - Arlington, VA; Casper, WY; Lakewood, CO; Portland, OR; Jackson, WY; San Pedro, CA; Cheyenne, WY; Colorado Springs, CO
The Wilderness Society - Washington, D. C.; Denver, CO; Elko, NV; Hamilton, MT; Boise, ID; San Francisco, CA; Helena, MT; Moose, WY; Seattle, WA; Lakewood, CO
Wildlife Society - Flagstaff, AZ; Tulelake, CA; Portland, OR; Moiese, MT; Ephrata, WA; Lander, WY; Sparks, NV; Cheyenne, WY
Trout Unlimited, Inc. - Eugene, OR; Livingston, MT; Olympia, WA; Victor, MT; Bozeman, MT; Denver, CO; Salt Lake City, UT; Cheyenne, WY; Santa Rosa, CA
Environmental Information Center - Helena, MT; Missoula, MT; Boulder, CO; Salt Lake City, UT; Arcata, CA; Kalispell, MT

Environmental Defense Fund, Inc. - Santa Barbara, CA; Berkeley, CA;
Boulder, CO
Friends of the Earth - Moab, UT; Billings, MT; San Francisco, CA;
Denver, CO; Palisade, CO
League of Women Voters - Boise, ID; Salt Lake City, UT; Denver, CO;
Lakewood, CO; Littleton, CO; Carson City, NV
Conservation Foundation - Washington, D. C.
The Nature Conservancy - Boulder, CO; Helena, MT; Arlington, VA;
San Francisco, CA; Ft. Collins, CO
National Forest Recreation Association - Mt. Laguna, CA
National Resources Defense Council - San Francisco, CA;
New York, NY
Eastern Sierra Packers Association - Bishop, CA
Colorado Mountain Club - Denver, CO
American Wilderness Alliance - Denver, CO
Cattlemen's Association - Payette, ID; Salt Lake City, UT
Idaho Alpine Club - Boise, ID
Wool Growers Association - Salt Lake City, UT; Buhl, ID; Ely, NV
Environmental Council - Boise, ID; Idaho Falls, ID; Portland, OR
Trout - Bend, OR
Idaho Trails Council - Idaho Falls, ID
Outfitters and Guides Association - Boise, ID; Brewster, WA;
Denver, CO; Hot Springs, MT
Idaho Federation of Western Outdoor Clubs - Idaho Falls, ID
National Wildlife Committee - Salmon, ID
Idaho Conservation League - Boise, ID
North American Outfitters, Inc. - Hot Springs, MT
Back Country Horsemen of America - Columbia Falls, MT
Wilderness Association - Helena, MT; Salt Lake City, UT; Bozeman, MT
Wildland and Resources Association - Great Falls, MT
Inter-Tribal Council of Nevada - Reno, NV
Nevada Mining Association - Reno, NV
Nevada Association of Soil Conservation Districts - Jiggs, NV
Nevada Recreation and Park Society - Carson City, NV
1000 Friends of Oregon - Portland, OR
Oregon Natural Resources Council - Eugene, OR
Wilderness Coalition - Seattle, WA; Davis, CA; Salt Lake City, UT;
Eugene, OR
Mountaineers - Seattle, WA
North Cascades Conservation Committee - Seattle, WA
Environmental Testing & Balancing Inc. - Snoqualmie, WA
Alpine Lakes Protection Society - Seattle, WA
Olympic Park Association - Seattle, WA
Guides and Outfitters - Salt Lake City, UT; Loma, CO; Kamas, UT
Women's Conservation Council of Utah - Midvale, UT
Outdoors Unlimited - Salt Lake City, UT
Utah Water Users Association - Bountiful, UT
Utah Water Resources Council - Salt Lake City, UT
Utah Legislative Council - Salt Lake City, UT
Utah Association of Counties - Salt Lake City, UT
Utah Farm Bureau Federation - Salt Lake City, UT
Utah Wildlife and Outdoor Recreational Federation - Salt Lake City, UT

Wilderness Association - Salt Lake City, UT; Kalispell, MT; Lander, WY
Wasatch Mountain Club - Salt Lake City, UT
Wyoming Outdoor Council - Cheyenne, WY; Cora, WY
Wyoming Heritage Society - Cody, WY
Skinner Brothers Wilderness School - Pinedale, WY
Wyoming Outdoor Council - Cheyenne, WY
Bridger Wilderness Outfitters - Pinedale, WY
Outfitters Association - Pinedale, WY; Jackson, WY
Jackson Hole Alliance for Responsible Planning - Jackson, WY
Sublette Wildlife Association - Pinedale, WY
Oregon Guides and Packers - Portland, OR; Grants Pass, OR
Powder River Sportsmen - Baker, OR
Outfitters Professional Society - Aurora, CO
Western Cordillera - Bakersfield, CA
Evans, Carey and Crozier - Bakersfield, CA
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MRNPA, Roger C. Garrett - Tigard, OR
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Colorado Mountain Club - Denver, CO; Boulder, CO
CERT, Warner Reeser - Englewood, CO
Greenpeace - Denver, CO
National Resources Defense Council - Denver, CO
American Friends Service Committee - Denver, CO
American Lung Association - Denver, CO
Clean Air Coalition for Health and Jobs - Denver, CO
Colorado Environmental Health Association - Boulder, CO
Native Plant Society - Denver, CO; Berkeley, CA
Inter-Tribal Council of California - Sacramento, CA
Colorado Outdoor Education Center - Florissant, CO
Outward Bound School - Denver, CO
Earth First! - Jackson, WY
Open Space Council, Inc. - Denver, CO; Cheyenne, WY
Outdoor Council, Inc. - Cheyenne, WY; Jackson, WY
Colorado Public Interest Research Group, Inc. - Denver, CO
Colorado Rivers Council - Denver, CO
Colorado Trappers Association - Golden, CO
Colorado Water Congress - Denver, CO
Colorado White Water Association - Denver, CO; Boulder, CO
Crystal Valley Environmental Protection Association - Carbondale, CO
CSU Environmental Corps - Ft. Collins, CO
Denver Parks and Recreation Foundation - Denver, CO
Denver Regional Council of Governments - Denver, CO
Elsa Wild Animal Appeal - Denver, CO; North Hollywood, CA
High Country Citizens Alliance - Crested Butte, CO
Keep Colorado Beautiful, Inc. - Denver, CO
National Environmental Health Association - Denver, CO
Northwest Rivers Alliance - Steamboat Springs, CO
Pavilion of Science-Technology - Denver, CO
Pikes Peak Solar Energy - Colorado Springs, CO
Plan Boulder - Boulder, CO
Preserve Our Poudre - Ft. Collins, CO

Protect Our Mountain Environment - Evergreen, CO
Regional Energy/Environment, Information Center of the Conservation
Library - Denver, CO
Western Slope Energy Research - Paonia, CO
Wildlife Resources - Denver, CO
Montana Historical Society - Helena, MT
Alternative Energy Resources Organization - Billings, MT
American Wilderness Alliance - Helena, MT
Cabinet Resource Group - Troy, MT
Coalition for Canyon Preservation - Billings, MT
Defenders of Wildlife - Missoula, MT
Flathead Wildlife, Inc. - Kalispell, MT
Headwaters Alliance - Missoula, MT
Libby Rod and Gun Club - Libby, MT
Montana Audubon Council - Billings, MT
Northern Plains Resource Council - Billings, MT
Northern Rockies Action Group - Helena, MT
Northwest Citizens for Wilderness - Helena, MT
Wildlands and Resources Association - Great Falls, MT
Utah State Historical Society - Salt Lake City, UT
Citizens Committee to Save Our Canyons - Salt Lake City, UT
Defenders of the Outdoor Heritage - Salt Lake City, UT
Ducks Unlimited - Salt Lake City, UT
Issue - Cedar City, UT
Save Our Public Land - Salt Lake City, UT
Save Our Rivers Committee - West Bountiful, UT
Slickrock County Council - Moab, UT
Intermountain Water Alliance - Salt Lake City, UT
Source - Provo, UT
Utah Heritage Foundation - Salt Lake City, UT
Utah Lung Association - Salt Lake City, UT
Utah Nature Study Society - Salt Lake City, UT
Jackson Hole Land Trust - Jackson, WY
Powder River Basin Resource Council - Sheridan, WY
Wyoming Heritage Foundation - Cody, WY
Washoe Council of Governments - Reno, NV
Nevada Water Pollution Control Association - Las Vegas, NV
Nevada Water Resources Association - Carson City, NV
Tahoe Regional Planning Agency - South Lake Tahoe, CA
Ecology Center - Berkeley, CA
California Council on Intergovernmental Relations - Sacramento, CA
Arizona Association of Conservation Districts - Woodruff, AZ
Arizona Bass Chapter Federation - Phoenix, AZ
Arizona Conservation Council - Phoenix, AZ
Safari Club International, Arizona Chapter - Tucson, AZ
California Natural Resources Federation - Sacramento, CA
California Forest Protective Association, - Sacramento, CA
California Tomorrow - San Francisco, CA
California Trout, Inc. - San Francisco, CA
California Wildlife Defenders - Hollywood, CA
Council for Planning and Conservation - Beverly Hills, CA
Natural Resource Biologists Association - Sloughhouse, CA

Planning and Conservation League - Sacramento, CA
Rocky Mountain Bighorn Society - Denver, CO
Montana Land Reliance - Helena, MT
Northern Rockies Action Group, Inc. - Helena, MT
Environmental Education Project - Portland, OR
Oregon Bass Chapter Federation - Pendleton, OR
ONRC - Eugene, OR
Oregon Student Public Interest Research Group - Portland, OR
Washington Environmental Council, Inc. - Seattle, WA
Richland Ecology Commission - Richland, WA
Wyoming Recreation Commission - Cheyenne, WY
National Parks and Conservation - Washington, D. C.
CMC Conservation - Denver, CO; Boulder, CA
Boise Cascade Corporation - Boise, ID
Kennecott Corporation - Salt Lake City, UT
University of Nevada-Reno, College of Agriculture - Reno, NV
Utah State University - College of Natural Resources; Utah Coop
    Fishery Unit - Logan, UT
Western Washington University, Dave Brakke - Bellingham, WA
University of Washington - Civil Engineering; Washington State
    Forestry Conf. - Seattle, WA
University of Montana - KUFM; Department of Botany - Missoula, MT
Colorado State University - Grasslands Lab.; Forest Pathology -
    Ft. Collins, CO
University of Colorado - Wilderness Study Group; Environmental
    Center - Boulder, CO
Brigham Young University, Aquatic Ecology Lab. - Provo, UT
University of Utah, Brine Shrimp Alliance - Logan, UT
North Carolina State University - Raleigh, NC
Kilkelly Environmental Assoc. - Raleigh, NC

Citizens

Craig Parsley - Snoqualmie, WA
Ernest E. Day - Boise, ID
Morey Haggin - Spokane, WA
Chris Yoder - Boise, ID
Ralph Maugham - Pocatello, ID
Dean Stepanek - Billings, MT
Jim Curtis - Missoula, MT
Ed Madej - Helena, MT
Virlis Fischer - Las Vegas, NV
Dean Rhodes - Tuscarora, NV
Bruce Henderson - Portland, OR
Jack Desmond - Eugene, OR
Bruce Boccard - Ashland, OR
Charlie Raines - Seattle, WA
Anne Bringloe - Bainbridge Island, WA
Rick Rutz - Seattle, WA
Tom May - Spokane, WA
Peter Coppelman - Washington, D. C.
Diane Hunsucker - Boise, ID
Robert Oset - Hamilton, MT
Bill Worf - Stevensville, MT
Peter Hovingh - Salt Lake City, UT
Richard Denton - Bountiful, UT
James R. Hunter - Bend, OR
Winchell T. Hayward - San Francisco, CA
William F. Boyd - Kellogg, ID
Jane Horton Mulcahy - Livingston, MT
James M. Mulcahy - Livingston, MT
Fred L. Cavill - Plains, MT
Melissa Lotz - Bow, WA
Mrs. Wil Smith - Sisters, OR
Edward W. Styskel, Bend, OR
Paul C. Paulsen - Portland, OR
Ralph M. Jackson - Burlington, WA
Arnie Arneson - Wenatchee, WA
Vivian Rico - Bellingham, WA
Paul B. McCarthy - Idaho Falls, ID

7. REFERENCES

Alm, A. L. 1984. Memorandum from Deputy Administrator, April 17. U.S. Environmental Protection Agency, Washington, D.C.

American Public Health Association (APHA), American Water Works Association (AWWA), and Water Pollution Control Federation (WPCF). 1980. Standard Methods for the Examination of Water and Wastewater. Fifteenth Edition. Washington, D.C.

Barnes, R. B. 1975. The determination of specific forms of aluminum in natural water. Chemical Geology 15: 177-191.

Beamish, R. J. and H. H. Harvey. 1972. Acidification of the LaCloche mountain Lakes, Ontario, and resulting fish mortalities. J. Fish. Res. Bd. Canada 29:1131-1143.

Bennett, D. A. 1985. Present Data Resources, Limitations of Present Data for Assessment. Memorandum to NSWS Management Personnel, Jan. 18. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

Birnbaum, Z. W. and M. G. Sirken. 1950. Bias due to nonavailability in sampling surveys. J. Amer. Stat. Assoc. 45:98-111.

Bureau of Sport Fisheries and Wildlife. 1973. Threatened Wildlife of the United States. Resource Publication 114. U.S. Fish and Wildlife Service. Washington, D.C.

Burks, S.L. 1982. Effects of Oil on Aquatic Organisms. American Petroleum Institute, Washington, D.C.

California Air Resources Board. 1983. Facts About Acid Precipitation in California. Sacramento, California. 7 pp.

Campbell, P. G. C., R. Bougie, A. Tessier, and J. -P. Villeneuve. 1984. Aluminum speciation in surface waters on the Canadian Pre-Cambrian Shield. Verh. Internat. Verein. Limnol. 22:371-375.

Campbell, P. G. C., M. Bisson, R. Bougie, A. Tessier, and J. -P. Villeneuve. 1983. Speciation of aluminum in acidic freshwaters. Anal. Chem. 55(14):2246-2252.

Chapman, J. A., and G. A. Feldhamer (eds.). 1982. Wild Mammals of North America. Biology, Management, and Economics. John Hopkins University Press. 1147pp.

Coate, L. E. 1985. Status Report for the Western Lake Survey. Memorandum (Jan. 31, 1985) to A. James Bomes, Acting Deputy Administration, U.S. Environmental Protection Agency, Washington, D.C.

Cochran, W. G. 1977. Sampling Techniques. 3rd edition. John Wiley and Sons, Inc., New York. 428pp.

Deitemeyer, S. 1984. Introduction. pp. 5-7. IN Workshop, Air Quality and Acid Deposition in the Wind River Mountains, Wyoming. March 14-15, Fort Collins, Colorado. USDA Forest Service, Intermountain Region, Ogden, Utah.

Drabelle, Dennis. 1984. "Feral Explorations: Wilderness as the Landscape of Science," Wilderness, Summer, pp.24-6.

Driscoll, C. T. 1982. April Quarterly Report for EPA Project No. APP-0094-1981, "The Chemistry, Transport, and Fate of Aluminum in Dilute Acidified Lake Systems." Syracuse University, Syracuse, New York.

Driscoll, C. T. 1984. A procedure for the fractionation of aqueous aluminum dilute acidic waters. Intern. J. Environ. Anal. Chem. 16:267-283.

Driscoll, C. T., Jr., J. P. Baker, J. J. Bisogni, Jr., and C. L. Schofield. 1980. Effect of aluminum speciation on fish in dilute acidified waters. Nature 284: 161-164.

Driscoll, C. T., and G. C. Schafran. 1984. Annual Report for EPA Project No. APP-0310-1983, "An Evaluation of Aluminum in Acidic Lake Ecosystems: Sources, Fate and Role in Nutrient Cycling." Syracuse University, Syracuse, New York.

Dufour, P. A. 1980. Effects of Noise on Wildlife and Other Animals: Review of Research Since 1971. EPA Rep. 550/9-80-100. U.S. Environmental Protection Agency, Washington, D.C.

Environmental Defense Fund. 1981. "Acid Rain" Research in the Intermountain West. September, 1981. Washington, D.C. 18pp.

Flath, D. (Nongame Biologist, Montana Dept. Fish, Wildlife, and Parks, Bozeman, Montana) 1984 Letter to J. W. Webb, Oak Ridge National Laboratory, December 11, 1984.

Fletcher, C. 1984. The Complete Walker III, Random House, Westminster, MD.

Franklin, J. F. 1978. "Wilderness Ecosystems," in Hendee, J. C., Stankey, G. H., and Lucas, R. C. Wilderness Management, U.S. Department of Agriculture, Forest Service, Miscellaneous Publication No. 1365, Washington, D.C., pp.191-212.

Galbraith, A. F. 1984. The acid deposition potential for the streams and lakes of the Wind River Mountains. pp. 275-292. IN Workshop, Air Quality and Acid Deposition in the Wind River Mountains, Wyoming. March 14-15, Fort Collins, Colorado. USDA Forest Service, Intermountain Region, Ogden, Utah.

Galloway, J. N., B. J. Cosby, Jr., and G. E. Likens. 1979. Acid precipitation: measurement of pH and acidity. Limnol. Oceanogr. 24(6):1161-1165.

Galloway, J. N. et al. 1984. Effects on aquatic chemistry. pp. 4-1 to 4-197. IN The Acidic Deposition Phenomenon and Its Effects, Vol. II. EPA-600/8-83-016BF. U.S. Environmental Protection Agency. Office of Research and Development, Washington, D.C.

Godfrey-Smith, W. 1979. "The Value of Wilderness," Environmental Ethics, V.1, No. 4, pp.309-19.

Green, R. H. 1979. Sampling Design and Statistical Methods for Environmental Biologists. John Wiley and Sons, Inc., New York. 257pp.

Haddow, D. V. 1984. Forest Service responsibilities in the PSD permitting process, IN Proceedings of the March 1984 Workshop on Air Quality and Acid Deposition Potential in the Bridger and Fitzpatrick Wilderness, p. 22-28.

Hammitt, W. 1982. "Cognitive Dimensions of Wilderness Solitude," Environment and Behavior, Vol. 14, No. 4, July, pp. 478-493.

Hammitt, W. E., and Brown, G. F., Jr. (In Press). "Functions of Privacy in Wilderness Environments," submitted to Leisure Sciences.

Hendee, J. C. and C. Schoenfeld. 1978. "Wildlife in Wilderness," IN Hendee, J. C., G. H. Stankee, and R. C. Lucas, Wilderness Management, U.S. Department of Agriculture, Forest Service, Washington, D.C., Miscellaneous Publication No. 1365, pp.215-247.

Hendee, J. C., G. H. Stankey, and R. C. Lucas, 1978. Wilderness Management, Forest Service, U.S. Department of Agriculture, Washington, D.C., Miscellaneous Publication No. 1365.

Henriksen, A., O. K. Skogheim, and B. O. Rosseland. 1984. Episodic changes in pH and aluminum-speciation kill fish in a Norwegian salmon river. Vatten 40:255-260.

Hillman, D. C. 1984. Lockheed Environmental Programs Office, 10 December letter to E. P. Meier, U.S. Environmental Protection Agency, Las Vegas, Nevada.

Hillman, D. C., F. A. Morris, J. F. Potter, and S. J. Simon. 1984. Methods Manual for the National Surface Water Survey Project - Phase I (revision 3). U.S. Environmental Protection Agency, Las Vegas, Nevada.

Jakimchuk, R. D., E. A. De Bock, H. J. Russell, and G. R. Semechuk. 1974. A study of the Porcupine caribou herd. Arctic Gas Biological Report Series, Vol. IV.

Kaplan, S. 1983. "A Model of Person-Environment Compatibility," Environment and Behavior, Vol. 15, No. 3, May, pp.311-332.

Kaplan, S. and J. F. Talbot. 1983. "Psychological Benefits of a Wilderness Experience," in Irwin Altman and Joachim F. Wohlwill (eds.), Behavior and the Natural Environment, Plenum Press, New York, pp.163-203.

Kennedy, V. C., G. W. Zellweger, and B. F. Jones. 1974. Filter pore-size effects on the analysis of Al, Fe, Mn, and Ti in water. Water Resources Research 10: 785-790.

Koch, W. F., and G. Marinenko. 1983. Simulated precipitation reference materials: measurement of pH and acidity. pp. 10-17. IN Sampling and Analysis of Rain (S. A. Campbell, ed.), ASTM STP 823. American Society for Testing and Materials, Phila.

Kling, G. W., and M. C. Grant. 1984. Acid precipitation in the Colorado Front Range: An overview with time predictions for significant effects. Arctic and Alpine Res. 16 (3): 321-329.

Kramer, J. R. 1984. Report to E. Meier, U.S. Environmental Protection Agency, Las Vegas, Nevada, regarding analytical procedures with respect to protolytes in the NAPAP lake monitoring program. Ancaster, Ontario.

Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister, and J. R. Stauffer, Jr., 1980. Atlas of North American Freshwater Fishes. North Carolina State Museum of Natural History, Raleigh.

McAuliffe, C. D. 1979. Dispersion and alteration of oil discharged on a water surface. pp. 363-373. IN D. A. Wolfe (ed.). Fate and Effects of Petroleum Hydrocarbons in Marine Organisms and Ecosystems. Pergamon Press, Elmsford, New York.

McCourt, K. H., J. J. Russell, D. Doll, J. D. Feist, and W. McCrory. 1974. Distribution and movements of the Porcupine caribou herd in the Yukon, 1972. Arctic Gas Biological Report Series, Vol. 4.

McQuaker, N. R., P. D. Kluckner, and D. K. Sandberg. 1983. Chemical analysis of acid precipitation: pH and acidity determinations. Environ. Sci. Technol. 17(7):431-435.

Michael, D. I. 1984. Development of Data Quality Objectives for Phase I of the National Lake Survey. Radian Corporation, McLean, Virginia.

Miller, G. T., Jr. 1975. Living in the Environment: Concepts, Problems, and Alternatives , Wadsworth Publishing Co., Belmont, California.

Nash, R. 1978. "Historical Roots of Wilderness Management," in Hendee, J. C., Stankey, G. H., and Lucas, R. C., Wilderness Management, U.S. Department of Agriculture, Forest Service, Miscellaneous Publication No. 1365, Washington, D.C., pp.27-40.

National Transportation Safety Board (NTSB). 1981a. Special Study -- Review of Rotorcraft Accidents, 1977-1979 , National Transportation Safety Board, Bureau of Technology, Washington, D.C., 20594, NTSB-AAS-81-1.

__________. 1981b. Briefs of Accidents involving Rotorcraft, U.S. General Aviation, 1979 , National Transportation Safety Board, Bureau of Technology, Washington, D.C. 20594, NTSB-AMM-81-4.

__________. 1984a. Annual Review of Aircraft Accident Data - U.S. General Aviation - Calendar Year 1980, National Transportation Safety Board, Bureau of Safety Programs, Washington, D.C., 20594, NTSB/ARG-84/01.

__________. 1984b. Annual Review of Aircraft Accident Data - U.S. General Aviation - Fiscal Years 1975-1981, National Transportation Safety Board, Bureau of Safety Programs, Washington, D.C., NTSB/ARG-84/02.

Nelson, P. O., and G. K. Delwiche. 1983. Sensitivity of Oregon's Cascade Lakes to Acid Precipitation. WRRI-85. Water Resources Research Institute, Oregon State Univ., Corvallis, Oregon. 55pp.

Newman, J. S., E. J. Rickley, T. L. Bland, and K. R. Beattie. 1984. Noise Measurement Flight Test: Data/Analyses Hughes 500 D/E Helicopter, U.S. Department of Transportation, Federal Aviation Administration, Office of Environment and Energy, Noise Abatement Division, Noise Technology Branch, Washington, D.C. 20591, Report No. FAA-84-3.

Newman, J. S., E. J. Rickley, and T. L. Bland. 1982. Helicopter Noise Exposure Curves for Use in Environmental Impacts Assessment. DOT-FAA-EE-82-16. U.S. Department of Transportation, Federal Aviation Administration, Office of Environment and Energy, Washington, D.C.

Norton, S. A., and A. Henriksen. 1983. The importance of CO_2 in evaluation of effects of acid deposition. Vatten 39:346-354.

National Park Service (NPS). 1985. Letter from Daniel J. Tobin, Regional Director, National Park Service Pacaific Northwest Region, to Ronald A. Lee, Environmental Protection Agency, Jan. 11, 1985.

Oak Ridge National Laboratory (ORNL). 1981 and revisions. Hazardous materials controlled by ORNL. Report 7017. Oak Ridge, Tennessee.

Omernik, J. M., and A. J. Kinney. 1984. Total Alkalinity of Surface Waters: A Map of the New England and New York Region. Preliminary Draft EPA Report.

Omernik, J. M., and C. F. Powers. 1983. Total alkalinity of surface waters -- a national map. Ann. Assoc. Am. Geog. 73: 133-136.

Ono, R. D., J. D. Williams, and A. Wagner. 1983. Vanishing Fishes of North America. Stone Wall Press, Washington, D.C.

Powers, C. F., and M. O. Allum. 1984. Appendix to draft Annual Report on the EPA Program for Long-Term Monitoring of Surface Waters in the United States. U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory, Corvallis, Oregon.

Powers, C. F., and D. L. Rambo. 1981. The occurrence of acid precipitation on the West Coast of the United States. Envir. Monit. and Assess. 1:93-105.

Schomer, P. D. and B. L. Homans. 1976. User Manual: Interim Procedure for Planning Rotary-Wing Aircraft Traffic Patterns and Siting Noise-Sensitive Land Uses, U.S.Army Construction Engineering Research Laboratory, Champaign, Illinois, Interim Report, N-10.

Seip, H.M., L. Mueller, and A. Naas. 1984. Aluminum speciation: comparison of two spectrophotometric analytical methods and observed concentrations in some acidic aquatic systems in southern Norway. Water, Air, and Soil Pollution 23: 81-95.

Snedecor, G. W., and W. G. Cochran. 1967. Statistical Methods. 6th Edition. The Iowa State University Press, Ames, Iowa. 593 pp.

Stuart, S. 1984. Hydrology and aquatic chemistry of monitor lake watersheds in the Wind River Mountains. pp. 130-173. IN Workshop, Air Quality and Acid Deposition in the Wind River Mountains, Wyoming. March 14-15, Fort Collins, Colorado. USDA Forest Service, Intermountain Region, Ogden, Utah.

The Wilderness Society. 1984. The Wilderness Act Handbook, The Wilderness Society Forest Management Program, The Wilderness Society, Washington, D.C.

Turk, J. T. 1984a. Controls on the Variance in Chemistry of Three Lakes in the Flat Tops Wilderness Area, Colorado. Open-File Report 84-723. USGS, Lakewood, Colorado.

Turk, J. T. 1984b. Determination of pH in dilute lakes: precision under field conditions. Submitted to Water, Air, and Soil Pollution.

Turk, J. T., and D. B. Adams. 1983. Sensitivity to acidification of lakes in the Flat Tops Wilderness Area, Colorado. Water Resour. Res. 19(2):346-350.

Ulph, Owen. 1982. "A Wilderness Manifesto, Or, Is Nature Too Good for William Tucker?" Wilderness, Winter, pp.30-8.

U. S. Department of Agriculture (USDA). undated. Forest Service Manual. Title 2300, Recreation Management. Forest Service, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1976. Quality criteria for water. Washington, D.C.

__________. 1983. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020. Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

__________. 1984a. National Surface Water Survey. National Lake Survey -- Phase I. April 30, 1984. Office of Research and Development, Washington, D.C.

__________. 1984b. National Surface Water Survey, Phase I Research Plan, A Summary of Review Comments. Corvallis, Oregon.

__________. 1984c. Workshop on Analytical and QA Strategy for the Phase I National Lake Survey, Acid Deposition Program, Denver Colorado, January 10-11, 1984. Transmitted by E. Meier, EPA, Las Vegas, Nevada, to R. Reed, ORNL, 3 January 1985.

__________. 1984d. Justification for Helicopter Access, transmitted by J. S. Huang, EPA, Washington, D.C., to L. E. Coate, EPA, Region X, Seattle, Washington, December 4, 1984.

__________. 1984e. Letter from Richard T. Dewling, EPA, Region II, New York, to Larry Henson, FS, Milwaukee, Wisconsin, September 14, 1984.

__________. 1984f. Preliminary Report, Western Pilot Survey, Logistics and Sampling. Region VIII, Denver, Colorado.

__________. 1984g. The Acidic Deposition Phenomenon and Its Effects, Vol. II. EPA-600/8-83-016BF. Office of Research and Development, Washington, D.C.

U.S. Fish and Wildlife Service (FWS). 1982. Endangered Species Technical Bulletin 7(3):8.

__________. 1984a. Endangered and Threatened Wildlife and Plants. 50 CFR 17.11 and 17.12, July 20, 1984. U.S. Govt. Printing Office, 24 pp.

__________. 1984b. Endangered Species Tech. Bull. 8(11):7.

Welch, E. P., and D. E. Spyridakis. 1984. Acidification Potential in High Mountain Lakes in Washington. Final Report (Research Contract C-84039) to State of Washington Department of Ecology, Olympia. 16pp.

Wetzel, R. G. 1975. Limnology. W. B. Saunders Co., Phila.

Wilson, D. and R. Wood. 1984. Mountain Lake Water Quality Survey - 1983. Region 1 Data Report. State of California Department of Fish and Game, Sacramento, California.

Yuhnke, R. E., and M. Oppenheimer. 1984. Safeguarding Acid-Sensitive Waters in

the Intermountain West. Report prepared by the Environmental Defense Fund. November 26, 1984. Washington, D.C. 28pp.

Zaslowsky, D. 1984. "Managing the Dream: Recreation, Contradiction, and the Pressures of Enchantment," Wilderness, Summer, pp.27-33.

APPENDIX A

LIST OF LAKES PROPOSED FOR SAMPLING IN WILDERNESS AREAS AND NATIONAL PARKS

Table A-1. List of lakes in federally designated wilderness areas.

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		CALIFORNIA			
BUCKS LAKE	GOLD LAKE	4A3-022	39-56'27"N	121-08'05"W	5
CARIBOU	(NO NAME)	4A2-060	40-28'30"N	121-14'27"W	5
CARIBOU	BLACK LAKE	4A2-002	40-30'25"N	121-12'38"W	5
CARIBOU	HIDDEH LAKES (EASTERN)	4A2-005	40-27'12"N	121-11'35"W	5
CARSON-ICEBERG	(NO NAME)	4A2-035	38-24'58"N	119-56'43"W	5
DESOLATION	AZURE LAKE	4A3-032	38-55'16"N	120-07'25"W	5
DESOLATION	DICKS LAKE	4A2-024	38-54'45"N	120-08'30"W	5
DESOLATION	FONTANILLIS LAKE	4A2-058	38-55'12"N	120-09'05"W	5
DESOLATION	FORNI LAKE	4A2-022	38-57'17"N	120-15'42"W	5
DESOLATION	GRASS LAKE	4A3-034	38-52'22"N	120-06'40"W	5
DESOLATION	GROUSE LAKE	4A2-025	38-51'28"N	120-11'54"W	5
DESOLATION	LAKE ALOHA	4A2-026	38-51'45"N	120-08'15"W	5
DESOLATION	LAKE LOIS	4A2-023	38-55'00"N	120-12'00"W	5
DESOLATION	ROCKBOUND LAKE	4A2-021	38-59'53"N	120-14'15"W	5
DESOLATION	ROPI LAKE	4A2-028	38-50'22"N	120-07'49"W	5
DESOLATION	WACA LAKE	4A2-064	38-51'18"N	120-08'25"W	5
DINKEY LAKES	(NO NAME)	4A2-041	37-11'26"N	119-04'41"W	5
DINKEY LAKES	LITTLE LAKE	4A2-042	37-09'30"N	119-02'37"W	5
EMIGRANT	(NO NAME)	4A1-005	38-07'53"N	119-43'58"W	5
EMIGRANT	COW MEADOW LAKE	4A1-058	38-08'35"N	119-44'10"W	5
EMIGRANT	LEOPOLD LAKE	4A1-004	38-10'39"N	119-48'16"W	5
EMIGRANT	LOST LAKE	4A1-003	38-13'49"N	119-38'51"W	5
HOOVER	HOOVER LAKES (NE)	4A1-012	38-03'27"N	119-17'50"W	4
JOHN MUIR	(NO NAME)	4A1-025	37-16'47"N	119-01'25"W	5
JOHN MUIR	BIG PINE LAKES(SECOND L.)	4A1-052	37-07'25"N	118-29'13"W	5
JOHN MUIR	BIG PINE LAKES(SIXTH L.)	4A1-031	37-08'10"N	118-30'40"W	5
JOHN MUIR	CHIEF LAKE	4A1-021	37-28'10"N	118-55'35"W	5
JOHN MUIR	DUCK LAKE	4A2-053	36-59'32"N	118-53'30"W	5
JOHN MUIR	HEATHER LAKE	4A1-028	37-11'20"N	118-51'07"W	5
JOHN MUIR	HORTON LAKE	4A1-054	37-19'00"N	118-40'00"W	5
JOHN MUIR	LAKE DOROTHY	4A1-051	37-32'20"N	118-52'55"W	5
JOHN MUIR	LAKE WIT-SO-NAH-PAH	4A1-020	37-31'35"N	118-52'30"W	5
JOHN MUIR	LITTLE SPANISH LAKE	4A2-044	36-55'43"N	118-54'26"W	5
JOHN MUIR	LONG LAKE	4A1-049	36-29'15"N	118-13'32"W	5
JOHN MUIR	MERRIAM LAKE	4A1-026	37-17'45"N	118-47'30"W	5
JOHN MUIR	NEIL LAKE	4A1-023	37-17'53"N	118-54'22"W	5
JOHN MUIR	REGIMENT LAKE	4A1-032	37-03'40"N	118-44'25"W	5
JOHN MUIR	UPPER LAMARCK LAKE	4A1-030	37-12'35"N	118-39'00"W	5
JOHN MUIR	VEE LAKE	4A1-024	37-19'20"N	118-48'30"W	5
JOHN MUIR	WAHOO LAKES (NW)	4A1-027	37-13'50"N	118-42'50"W	5
KAISER	NELLIE LAKE	4A3-047	37-16'52"N	119-14'45"W	5
KINGS CANYON	(NO NAME)	4A1-029	37-10'20"N	118-44'40"W	5
KINGS CANYON	(NO NAME)	4A1-033	37-01'45"N	118-41'45"W	5
KINGS CANYON	(NO NAME)	4A1-034	37-04'00"N	118-38'20"W	5
KINGS CANYON	(NO NAME)	4A1-035	37-01'37"N	118-29'30"W	5
KINGS CANYON	(NO NAME)	4A1-038	36-54'10"N	118-33'30"W	5
KINGS CANYON	(NO NAME)	4A1-040	36-48'15"N	118-25'10"W	5
KINGS CANYON	(NO NAME)	4A1-041	36-43'05"N	118-31'50"W	5
KINGS CANYON	(NO NAME)	4A1-053	36-48'40"N	118-25'49"W	5
KINGS CANYON	(NO NAME)	4A1-056	37-08'40"N	118-39'50"W	5
KINGS CANYON	HORSESHOE LAKES (MIDDLE)	4A1-036	36-56'37"N	118-34'15"W	5
KINGS CANYON	STOCKING LAKE	4A1-039	36-52'15"N	118-22'15"W	5
KINGS CANYON	SWAMP LAKES (WESTERN)	4A1-037	36-53'20"N	118-43'25"W	5
LASSEN VOLCANIC	(NO NAME)	4A3-010	40-31'27"N	121-24'48"W	5
LASSEN VOLCANIC	FEATHER LAKE	4A3-011	40-31'30"N	121-22'45"W	5
LASSEN VOLCANIC	LITTLE BEAR LAKE	4A3-072	40-31'22"N	121-24'21"W	5
LASSEN VOLCANIC	SHADOW LAKE	4A3-054	40-29'45"N	121-28'05"W	5
LASSEN VOLCANIC	SWAN LAKE	4A3-013	40-29'52"N	121-21'45"W	5

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		CALIFORNIA			
MARBLE MOUNTAINS	BIG ELK LAKE	4A2-049	41-32'46"N	123-13'23"W	5
MARBLE MOUNTAINS	CUDDIHY LAKES (LG.SW)	4A2-048	41-32'48"N	123-19'20"W	5
MARBLE MOUNTAINS	LOST LAKE	4A2-046	41-23'46"N	123-16'08"W	5
MARBLE MOUNTAINS	LOWER WRIGHT LAKE	4A2-050	41-35'00"N	123-05'08"W	5
MINARETS	CHIQUITO LAKE	4A2-054	37-32'08"N	119-26'10"W	5
MINARETS	ICEBERG LAKE	4A1-018	37-40'15"N	119-10'10"W	5
MINARETS	KIDNEY LAKE	4A1-014	37-53'50"N	119-11'45"W	5
MINARETS	NYDIVER LAKES (MIDDLE)	4A1-017	37-41'40"N	119-10'15"W	5
MINARETS	WALTON LAKE	4A1-019	37-37'22"N	119-21'52"W	5
MOKELUMNE	EMIGRANT LAKE	4A2-056	38-39'38"N	120-02'15"W	5
MOKELUMNE	FROG LAKE	4A2-030	38-41'16"N	119-59'05"W	5
MOKELUMNE	SHRINER LAKE	4A3-036	38-32'11"N	120-09'32"W	5
SEQUOIA	(NO NAME)	4A1-042	36-40'55"N	118-24'25"W	5
SEQUOIA	(NO NAME)	4A1-043	36-36'25"N	118-38'45"W	5
SEQUOIA	(NO NAME)	4A1-044	36-39'40"N	118-26'00"W	5
SEQUOIA	(NO NAME)	4A1-045	36-37'20"N	118-20'45"W	5
SEQUOIA	(NO NAME)	4A1-046	36-34'37"N	118-32'04"W	5
SEQUOIA	(NO NAME)	4A1-047	36-31'37"N	118-18'20"W	5
SEQUOIA	BIG FIVE LAKES (SMALL N)	4A1-048	36-29'04"N	118-31'10"W	5
SEQUOIA	WRIGHT LAKES(NW)	4A1-060	36-38'11"N	118-22'00"W	5
SISKIYOU	BUCK LAKE	4A2-047	41-48'54"N	123-41'16"W	5
SISKIYOU	DEVILS PUNCHBOWL	4A2-059	41-48'10"N	123-40'15"W	5
THOUSAND LAKES	BOX LAKE	4A3-008	40-43'15"N	121-34'17"W	5
THOUSAND LAKES	MAGEE LAKE	4A3-070	40-42'00"N	121-36'10"W	5
TRINITY ALPS	BIG BEAR LAKE	4A3-003	41-11'38"N	122-42'50"W	5
TRINITY ALPS	CANYON CREEK LAKES(NORTH)	4A1-050	40-58'33"N	123-01'27"W	5
TRINITY ALPS	GRANITE LAKE	4A3-060	40-57'10"N	122-51'25"W	5
TRINITY ALPS	LITTLE SOUTH FORK L	4A1-057	41-01'07"N	123-00'50"W	5
TRINITY ALPS	LONG GULTCH LAKE	4A2-055	41-11'30"N	122-55'05"W	5
TRINITY ALPS	LOWER BOULDER LAKE	4A3-002	41-14'21"N	122-47'38"W	5
TRINITY ALPS	STODDARD LAKE	4A3-004	41-09'08"N	122-45'18"W	5
TRINITY ALPS	SUGAR PINE LAKE	4A2-001	41-03'45"N	122-51'10"W	5
YOSEMITE	(NO NAME)	4A1-006	38-05'12"N	119-42'19"W	5
YOSEMITE	(NO NAME)	4A1-008	38-04'15"N	119-46'53"W	5
YOSEMITE	(NO NAME)	4A1-010	38-03'30"N	119-39'09"W	5
YOSEMITE	(NO NAME)	4A1-016	37-42'15"N	119-17'15"W	5
YOSEMITE	(NO NAME)	4A1-055	38-05'10"N	119-40'24"W	5
YOSEMITE	(NO NAME)	4A2-036	37-57'10"N	119-50'17"W	5
YOSEMITE	BINGAMAN LAKE	4A1-015	37-50'45"N	119-14'45"W	5
YOSEMITE	LAKE VERNON	4A1-009	38-00'50"N	119-43'22"W	5
YOSEMITE	MARY LAKE	4A1-007	38-08'39"N	119-33'40"W	5
YOSEMITE	ROOSEVELT LAKE	4A1-013	37-58'15"N	119-20'00"W	5
YOSEMITE	VOGELSANG LAKE	4A1-059	37-47'12"N	119-20'35"W	5
NOT IN WILDERNESS	(NO NAME)	4A3-006	40-58'59"N	121-52'02"W	5
NOT IN WILDERNESS	(NO NAME)	4A3-025	39-37'11"N	121-00'07"W	5
NOT IN WILDERNESS	(NO NAME)	4A3-028	39-17'52"N	120-09'30"W	5
NOT IN WILDERNESS	(NO NAME)	4A3-048	36-39'04"N	119-00'30"W	5
NOT IN WILDERNESS	(NO NAME)	4A3-050	36-05'32"N	118-49'10"W	5
NOT IN WILDERNESS	ANGORA LAKES (SW)	4A2-027	38-51'45"N	120-04'00"W	5
NOT IN WILDERNESS	BARE ISLAND LAKE	4A2-038	37-29'44"N	119-07'25"W	5
NOT IN WILDERNESS	BLUE LAKE	4A2-015	39-21'28"N	120-37'52"W	5
NOT IN WILDERNESS	BLUE LAKE	4A3-055	40-23'15"N	121-17'52"W	5
NOT IN WILDERNESS	BOWMAN LAKE	4A2-010	39-27'07"N	120-38'15"W	5
NOT IN WILDERNESS	CASCADE LAKES (WESTERN)	4A2-017	39-18'03"N	120-26'11"W	5
NOT IN WILDERNESS	CRYSTAL LAKE	4A3-045	37-35'35"N	119-01'02"W	5
NOT IN WILDERNESS	DEERHEART LAKE	4A3-018	40-14'15"N	120-59'10"W	5
NOT IN WILDERNESS	DONNELL LAKE	4A3-038	38-20'10"N	119-56'30"W	5
NOT IN WILDERNESS	EMERALD LAKE	4A3-012	40-28'05"N	121-31'04"W	5

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		CALIFORNIA			
NOT IN WILDERNESS	FOWLER LAKE	4A3-059	39-46'27"N	121-00'15"W	5
NOT IN WILDERNESS	FRENCH LAKE	4A2-013	39-22'25"N	120-32'00"W	5
NOT IN WILDERNESS	FRENCH MEADOWS RESERVOIR	4A3-051	39-06'38"N	120-27'30"W	5
NOT IN WILDERNESS	GLEN LAKE	4A2-003	40-27'12"N	121-15'54"W	5
NOT IN WILDERNESS	GOOSE LAKE	4A2-008	39-40'22"N	120-38'07"W	5
NOT IN WILDERNESS	HOCKETT LAKES (CENTER)	4A2-045	36-21'29"N	118-39'58"W	5
NOT IN WILDERNESS	HUCKLEBERRY LAKE	4A3-014	40-24'27"N	121-32'50"W	5
NOT IN WILDERNESS	INDEPENDENCE LAKE	4A3-069	39-26'30"N	120-16'30"W	5
NOT IN WILDERNESS	INDIAN CREEK RESERVOIR	4A3-053	38-45'00"N	119-46'40"W	5
NOT IN WILDERNESS	IRON CANYON RESERVOIR	4A3-005	41-02'38"N	121-59'00"W	5
NOT IN WILDERNESS	JUANITA LAKE	4A3-001	41-48'45"N	122-07'15"W	5
NOT IN WILDERNESS	LAKE ALMANOR	4A3-017	40-15'00"N	121-10'00"W	
NOT IN WILDERNESS	LAKE STERLING	4A2-051	39-21'20"N	120-29'15"W	5
NOT IN WILDERNESS	LEWISTON LAKE	4A3-007	40-44'37"N	122-48'00"W	5
NOT IN WILDERNESS	LILY LAKE	4A2-020	39-02'15"N	120-11'25"W	5
NOT IN WILDERNESS	LONG LAKE	4A2-057	39-17'33"N	120-25'50"W	5
NOT IN WILDERNESS	LONG LAKE	4A2-061	39-42'00"N	120-40'48"W	5
NOT IN WILDERNESS	LOST LAKES (EAST)	4A2-031	38-38'45"N	119-56'42"W	4
NOT IN WILDERNESS	LOWER ROCK LAKE	4A2-011	39-25'45"N	120-37'15"W	5
NOT IN WILDERNESS	MANZANITA LAKE	4A3-067	37-14'45"N	119-31'00"W	5
NOT IN WILDERNESS	MC KINSTRY LAKE	4A3-031	39-02'30"N	120-19'50"W	5
NOT IN WILDERNESS	MIDDLE LAKE	4A2-012	39-24'02"N	120-36'12"W	5
NOT IN WILDERNESS	MIRROR LAKE	4A2-040	37-12'52"N	119-07'25"W	5
NOT IN WILDERNESS	MUD LAKE	4A3-039	38-20'15"N	119-31'18"W	4
NOT IN WILDERNESS	MUD LAKES (EASTERN)	4A2-043	37-06'37"N	119-04'18"W	5
NOT IN WILDERNESS	NOBLE LAKE	4A1-001	38-31'40"N	119-46'35"W	4
NOT IN WILDERNESS	PICAYUNE LAKE	4A3-058	41-13'18"N	122-31'22"W	5
NOT IN WILDERNESS	PROSSER CREEK RESERVOIR	4A3-026	39-22'52"N	120-09'00"W	5
NOT IN WILDERNESS	ROUND LAKE	4A2-029	38-45'00"N	120-00'17"W	5
NOT IN WILDERNESS	S.P. LAKES (SE)	4A2-016	39-21'28"N	120-37'52"W	5
NOT IN WILDERNESS	SADDLE LAKE	4A3-021	39-59'13"N	121-20'57"W	5
NOT IN WILDERNESS	SAUCER LAKE	4A3-020	40-03'02"N	121-20'52"W	5
NOT IN WILDERNESS	SILVER LAKE	4A2-006	40-29'41"N	121-09'45"W	5
NOT IN WILDERNESS	SILVER LAKE	4A3-043	37-46'37"N	119-07'30"W	5
NOT IN WILDERNESS	SMITH LAKE	4A2-007	39-43'56"N	120-40'20"W	5
NOT IN WILDERNESS	SNAG LAKE	4A3-071	40-04'45"N	121-27'00"W	5
NOT IN WILDERNESS	SPIDER LAKE	4A2-062	39-00'45"N	120-16'20"W	5
NOT IN WILDERNESS	STAR LAKE	4A3-016	40-25'06"N	121-09'21"W	5
NOT IN WILDERNESS	STAR LAKES (NORTH)	4A2-037	37-31'00"N	119-32'44"W	5
NOT IN WILDERNESS	STEVENS LAKE	4A3-035	38-45'07"N	119-47'07"W	5
NOT IN WILDERNESS	STRAWBERRY LAKE	4A2-063	37-12'15"N	119-06'42"W	5
NOT IN WILDERNESS	SUMMIT LAKE	4A2-033	38-36'15"N	119-52'15"W	5
NOT IN WILDERNESS	SUMMIT LAKE	4A2-034	38-26'00"N	119-58'20"W	5
NOT IN WILDERNESS	THOMPSON LAKE	4A3-023	39-52'39"N	121-11'58"W	5
NOT IN WILDERNESS	THREE LAKES (NW)	4A3-056	39-58'10"N	121-13'15"W	5
NOT IN WILDERNESS	TWIN LAKES (NE)	4A3-066	38-10'00"N	119-20'00"W	4
NOT IN WILDERNESS	TWIN LAKES (NORTH)	4A3-044	37-37'18"N	119-00'22"W	5
NOT IN WILDERNESS	TWIN LAKES (SOUTH)	4A3-065	37-36'50"N	119-00'30"W	5
NOT IN WILDERNESS	UNION RESERVOIR	4A2-052	38-25'55"N	119-59'30"W	5
NOT IN WILDERNESS	UPPER SARDINE LAKE	4A2-009	39-36'30"N	120-38'00"W	5
NOT IN WILDERNESS	WILSON LAKE	4A3-061	40-20'20"N	121-26'00"W	5
NOT IN WILDERNESS	YUBA RESERVOIR	4A3-029	39-13'25"N	120-59'15"W	5

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		COLORADO			
COLLEGIATE PEAKS	GRIZZLY LAKE	4E3-062	39-03'02"N	106-35'38"W	2
COMANCHE PEAK	EMMALINE LAKE	4E1-009	40-32'34"N	105-39'41"W	2
EAGLES NEST	(NO NAME)	4E3-021	39-41'45"N	106-14'22"W	2
EAGLES NEST	UPPER PINEY LAKE	4E3-059	39-42'43"N	106-18'13"W	2
FLAT TOPS	(NO NAME)	4E2-063	39-57'12"N	107-17'07"W	2
FLAT TOPS	(NO NAME)	4E3-012	40-00'03"N	107-22'03"W	2
FLAT TOPS	(NO NAME)	4E3-061	39-54'10"N	107-10'48"W	2
FLAT TOPS	DEER LAKE	4E2-019	39-57'15"N	107-09'50"W	2
FLAT TOPS	JOHNNY MEYERS LAKE	4E3-017	39-50'28"N	107-09'44"W	2
FLAT TOPS	LITTLE TRAPPERS LAKE	4E3-015	39-59'24"N	107-12'30"W	2
FLAT TOPS	OYSTER LAKE	4E2-016	39-55'20"N	107-24'32"W	2
FLAT TOPS	SURPRISE LAKE	4E2-018	39-57'52"N	107-11'31"W	2
FLAT TOPS	TWIN LAKES (SOUTH)	4E2-017	39-56'48"N	107-17'30"W	2
HOLY CROSS	FANCY LAKE	4E3-054	39-24'27"N	106-29'55"W	2
HOLY CROSS	PARADISE LAKES (EAST)	4E3-026	39-21'08"N	106-29'05"W	2
HUNTER-FRYING PAN	GRANITE LAKES (NORTH)	4E3-027	39-14'30"N	106-34'16"W	2
HUNTER-FRYING PAN	INDEPENDENCE LAKE	4E3-052	39-08'37"N	106-34'00"W	2
INDIAN PEAKS	(NO NAME)	4E1-035	40-10'04"N	105-41'54"W	2
INDIAN PEAKS	(NO NAME)	4E1-046	40-00'05"N	105-41'10"W	2
INDIAN PEAKS	BLUE LAKE	4E1-040	40-05'20"N	105-37'10"W	2
INDIAN PEAKS	BOB LAKE	4E1-056	39-57'09"N	105-41'07"W	2
INDIAN PEAKS	CARIBOU LAKE	4E1-045	40-01'15"N	105-40'55"W	2
INDIAN PEAKS	CONEY LAKE	4E1-039	40-07'00"N	105-36'37"W	2
INDIAN PEAKS	CRATER LAKE	4E1-041	40-04'32"N	105-39'50"W	2
INDIAN PEAKS	ISLAND LAKE	4E1-036	40-08'50"N	105-40'00"W	2
INDIAN PEAKS	JASPER LAKE	4E1-048	39-58'45"N	105-39'45"W	2
INDIAN PEAKS	KING LAKE	4E1-049	39-56'25"N	105-41'13"W	2
INDIAN PEAKS	RED DEER LAKE	4E1-059	40-08'35"N	105-36'35"W	2
INDIAN PEAKS	UPPER DIAMOND LAKE	4E1-047	39-59'30"N	105-40'22"W	2
INDIAN PEAKS	WOODLAND LAKE	4E1-050	39-57'15"N	105-39'50"W	2
MAROON BELLS-SNOWMASS	(NO NAME)	4E3-032	39-00'44"N	106-56'58"W	2
MAROON BELLS-SNOWMASS	PIERRE LAKES (NW)	4E3-028	39-08'56"N	107-04'15"W	2
MT EVANS	(NO NAME)	4E2-051	39-35'43"N	105-42'12"W	2
MT EVANS	CHICAGO LAKES (LG.NORTH)	4E2-026	39-36'58"N	105-38'00"W	2
MT ZIRKEL	(NO NAME)	4E1-001	40-43'00"N	106-39'08"W	2
MT ZIRKEL	BEAR LAKES (NW)	4E2-011	40-46'36"N	106-38'00"W	2
MT ZIRKEL	BIG CREEK LAKE	4E1-003	40-39'40"N	106-44'00"W	2
MT ZIRKEL	BLUE LAKE	4E2-062	40-49'30"N	106-37'05"W	2
MT ZIRKEL	FISH HAWK LAKE	4E1-004	40-37'42"N	106-46'05"W	2
MT ZIRKEL	GOLD CREEK LAKE	4E2-010	40-46'55"N	106-40'42"W	2
MT ZIRKEL	LAKE MARGARET	4E1-005	40-38'00"N	106-45'15"W	2
MT ZIRKEL	LAKE OF THE CRAGS	4E1-052	40-39'00"N	106-42'36"W	2
MT ZIRKEL	MARTHA LAKE	4E2-013	40-33'30"N	106-40'57"W	2
MT ZIRKEL	MICA LAKE	4E2-008	40-49'26"N	106-42'30"W	2
MT ZIRKEL	PORCUPINE LAKE	4E1-006	40-37'08"N	106-43'02"W	2
MT ZIRKEL	PTARMIGAN LAKE	4E1-002	40-41'52"N	106-41'23"W	2
MT ZIRKEL	SEVEN LAKES (LG.EAST)	4E2-009	40-53'45"N	106-40'55"W	2
MT ZIRKEL	SLIDE LAKE	4E1-007	40-39'11"N	106-39'45"W	2
MT ZIRKEL	TWIN LAKES (SOUTH)	4E2-012	40-48'50"N	106-37'00"W	2
MT ZIRKEL	WEST FORK LAKE	4E2-007	40-54'42"N	106-45'48"W	2
NEVER SUMMER	PARIKA LAKE	4E3-009	40-22'52"N	105-56'13"W	2
SOUTH SAN JUAN	TOBACCO LAKE	4E3-049	37-17'52"N	106-33'45"W	2
SOUTH SAN JUAN	TRAIL LAKE	4E3-050	37-09'28"N	106-35'21"W	2
WEMINUCHE	(NO NAME)	4E2-037	37-41'06"N	107-29'47"W	2
WEMINUCHE	(NO NAME)	4E2-038	37-40'06"N	107-33'55"W	2
WEMINUCHE	(NO NAME)	4E2-039	37-38'13"N	107-35'26"W	2
WEMINUCHE	(NO NAME)	4E2-042	37-36'17"N	107-27'26"W	2
WEMINUCHE	COLUMBINE LAKE	4E2-040	37-35'54"N	107-35'55"W	2

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		COLORADO			
WEMINUCHE	GOOSE LAKE	4E2-052	37-35'50"N	106-58'18"W	2
WEMINUCHE	HIGHLAND MARY LAKES (S)	4E2-034	37-45'17"N	107-35'00"W	2
WEMINUCHE	LAKE MARIE	4E2-043	37-33'19"N	107-35'38"W	2
WEMINUCHE	MIDDLE UTE LAKE	4E2-054	37-38'52"N	107-28'27"W	2
WEMINUCHE	MOON LAKE	4E2-041	37-36'00"N	107-28'24"W	2
WEMINUCHE	SPRUCE LAKES (WEST)	4E3-044	37-30'45"N	106-52'05"W	2
WEMINUCHE	TRINITY LAKE	4E2-057	37-41'00"N	107-33'50"W	2
WEMINUCHE	TROUT LAKE	4E3-057	37-38'40"N	107-09'20"W	2
WEMINUCHE	VERDE LAKES (NW)	4E2-035	37-45'02"N	107-34'52"W	2
WEMINUCHE	WINDOW LAKE	4E2-044	37-32'15"N	107-04'30"W	2
WEST ELK	(NO NAME)	4E2-027	38-46'56"N	107-10'52"W	2
NOT IN WILDERNESS	(NO NAME)	4E1-011	40-29'15"N	105-38'40"W	2
NOT IN WILDERNESS	(NO NAME)	4E1-016	40-21'29"N	105-45'05"W	2
NOT IN WILDERNESS	(NO NAME)	4E1-017	40-20'35"N	105-43'55"W	2
NOT IN WILDERNESS	(NO NAME)	4E1-019	40-18'47"N	105-43'45"W	2
NOT IN WILDERNESS	(NO NAME)	4E1-055	40-02'15"N	105-37'37"W	2
NOT IN WILDERNESS	(NO NAME)	4E2-032	37-51'18"N	107-36'06"W	2
NOT IN WILDERNESS	(NO NAME)	4E3-007	40-43'53"N	105-23'30"W	2
NOT IN WILDERNESS	(NO NAME)	4E3-013	40-03'02"N	107-02'28"W	2
NOT IN WILDERNESS	(NO NAME)	4E3-016	39-59'10"N	105-59'05"W	2
NOT IN WILDERNESS	(NO NAME)	4E3-019	39-46'20"N	107-09'42"W	2
NOT IN WILDERNESS	(NO NAME)	4E3-031	39-04'58"N	107-49'49"W	2
NOT IN WILDERNESS	(NO NAME)	4E3-039	38-03'35"N	108-02'38"W	2
NOT IN WILDERNESS	(NO NAME)	4E3-043	37-38'15"N	107-47'58"W	2
NOT IN WILDERNESS	(NO NAME)	4E3-051	38-43'15"N	106-10'30"W	2
NOT IN WILDERNESS	(NO NAME)	4E3-053	37-52'30"N	107-46'46"W	2
NOT IN WILDERNESS	(NO NAME)	4E3-056	40-00'08"N	107-01'05"W	2
NOT IN WILDERNESS	ALBERT RESERVOIR	4E3-010	40-15'15"N	106-33'25"W	2
NOT IN WILDERNESS	ARROWHEAD LAKE	4E1-014	40-23'00"N	105-45'40"W	2
NOT IN WILDERNESS	AZURE LAKE	4E1-015	40-22'18"N	105-46'15"W	2
NOT IN WILDERNESS	BLACK LAKE	4E1-025	40-15'55"N	105-38'27"W	2
NOT IN WILDERNESS	BLACK LAKE NO. 2	4E3-022	39-32'53"N	106-13'20"W	2
NOT IN WILDERNESS	BLUEBIRD LAKE	4E1-051	40-11'30"N	105-39'15"W	2
NOT IN WILDERNESS	BOX LAKE	4E1-030	40-12'47"N	105-38'53"W	2
NOT IN WILDERNESS	CHATFIELD RESERVOIR	4E3-011	40-07'40"N	107-04'48"W	2
NOT IN WILDERNESS	CHIQUITA LAKE	4E1-013	40-26'28"N	105-40'42"W	2
NOT IN WILDERNESS	CLAYTON LAKE	4E2-023	39-53'22"N	105-41'03"W	2
NOT IN WILDERNESS	COW LAKE	4E2-028	38-49'12"N	106-25'40"W	2
NOT IN WILDERNESS	CRATER LAKES (NW)	4E2-022	39-54'02"N	105-41'00"W	2
NOT IN WILDERNESS	CROOKED CREEK RESERVOIR	4E3-024	39-25'29"N	106-39'11"W	2
NOT IN WILDERNESS	DOWDY LAKE	4E3-006	40-47'45"N	105-33'30"W	2
NOT IN WILDERNESS	DRY LAKES (2 FROM E)	4E2-047	38-01'51"N	105-35'11"W	2
NOT IN WILDERNESS	DUCK LAKE	4E2-025	39-34'45"N	105-43'30"W	2
NOT IN WILDERNESS	EUREKA LAKE	4E2-046	38-05'03"N	105-38'10"W	2
NOT IN WILDERNESS	FIFTH LAKE	4E1-029	40-12'47"N	105-40'44"W	2
NOT IN WILDERNESS	FINCH LAKE	4E1-038	40-11'00"N	105-35'33"W	2
NOT IN WILDERNESS	FOREST LAKES (LG.N)	4E2-055	39-55'17"N	105-40'23"W	2
NOT IN WILDERNESS	FOURTH LAKE	4E1-054	40-13'18"N	105-41'07"W	2
NOT IN WILDERNESS	GLASS LAKE	4E1-023	40-16'52"N	105-39'55"W	2
NOT IN WILDERNESS	GREEN LAKES (NE)	4E1-043	40-03'03"N	105-36'20"W	2
NOT IN WILDERNESS	GREEN LAKES (NORTHERN)	4E1-042	40-03'18"N	105-37'12"W	2
NOT IN WILDERNESS	GRIZZLY LAKE	4E2-014	40-30'40"N	106-39'23"W	2
NOT IN WILDERNESS	GRIZZLY LAKE	4E3-036	38-40'01"N	106-19'58"W	2
NOT IN WILDERNESS	HAYNACH LAKES (NW)	4E1-018	40-20'47"N	105-45'55"W	2
NOT IN WILDERNESS	HINMAN LAKE	4E3-060	40-46'18"N	106-49'35"W	2
NOT IN WILDERNESS	HUTCHESON LAKES(NORTHERN)	4E1-037	40-10'26"N	105-38'50"W	2
NOT IN WILDERNESS	ICE LAKE	4E2-033	37-48'49"N	107-48'30"W	2
NOT IN WILDERNESS	ISLAND LAKE	4E2-059	37-49'09"N	107-48'05"W	2

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		COLORADO			
NOT IN WILDERNESS	JEWEL LAKE	4E1-024	40-17'12"N	105-38'23"W	2
NOT IN WILDERNESS	JUNCO LAKE	4E1-034	40-11'01"N	105-39'45"W	2
NOT IN WILDERNESS	KAREL PARK LAKE	4E3-018	39-54'30"N	105-35'29"W	2
NOT IN WILDERNESS	KEPLINGER LAKE	4E1-032	40-14'33"N	105-37'28"W	2
NOT IN WILDERNESS	LAKE HAIYAHA	4E1-022	40-18'17"N	105-39'45"W	2
NOT IN WILDERNESS	LAKE HUSTED	4E1-010	40-30'35"N	105-36'36"W	2
NOT IN WILDERNESS	LAKE NANITA	4E1-027	40-15'23"N	105-43'00"W	2
NOT IN WILDERNESS	LAKE POWELL	4E1-026	40-15'17"N	105-39'35"W	2
NOT IN WILDERNESS	LAKE SIMPATI	4E3-045	37-19'20"N	107-35'12"W	2
NOT IN WILDERNESS	LAKE VERNA	4E1-028	40-13'35"N	105-42'28"W	2
NOT IN WILDERNESS	LEWIS LAKE	4E3-040	37-52'26"N	107-46'32"W	2
NOT IN WILDERNESS	LONE CABIN RESERVOIR	4E3-034	38-50'10"N	107-30'40"W	2
NOT IN WILDERNESS	LOOMIS LAKE	4E1-020	40-20'16"N	105-41'45"W	2
NOT IN WILDERNESS	LOST LAKES (NORTH)	4E3-041	37-45'39"N	107-18'40"W	2
NOT IN WILDERNESS	MACEY LAKES (WEST)	4E2-048	37-59'49"N	105-35'01"W	2
NOT IN WILDERNESS	MIDDLE RAINBOW LAKE	4E1-008	40-38'55"N	106-37'25"W	2
NOT IN WILDERNESS	MILLS LAKE	4E1-060	40-17'20"N	105-38'25"W	2
NOT IN WILDERNESS	MIRROR LAKE	4E1-053	40-32'15"N	105-41'52"W	2
NOT IN WILDERNESS	MIRROR LAKE	4E2-053	38-44'35"N	106-25'52"W	2
NOT IN WILDERNESS	MT MASSIVE LAKES (LG.NE)	4E3-029	39-09'22"N	106-17'52"W	2
NOT IN WILDERNESS	MURRAY LAKE	4E2-024	39-36'18"N	105-45'35"W	2
NOT IN WILDERNESS	NORTH CATAMOUNT RESERVOIR	4E3-035	38-55'35"N	105-03'45"W	2
NOT IN WILDERNESS	PANHANDLE RESERVOIR	4E3-005	40-51'10"N	105-39'10"W	2
NOT IN WILDERNESS	PATTERSON RESERVOIRS (W)	4E3-033	38-57'43"N	107-45'00"W	2
NOT IN WILDERNESS	PIONEER LAKE	4E2-050	37-34'44"N	105-30'22"W	2
NOT IN WILDERNESS	PTARMIGAN LAKE	4E2-029	38-46'38"N	106-23'03"W	2
NOT IN WILDERNESS	PUMPHOUSE LAKE	4E2-021	39-55'30"N	105-41'23"W	2
NOT IN WILDERNESS	RED ROCK LAKE	4E3-014	40-04'54"N	105-32'27"W	2
NOT IN WILDERNESS	SANDBEACH LAKE	4E1-033	40-13'08"N	105-36'05"W	2
NOT IN WILDERNESS	SHEEP LAKES (LG.NW)	4E3-055	40-24'17"N	105-37'15"W	2
NOT IN WILDERNESS	SILVER CREEK LAKES (NE)	4E3-038	38-23'52"N	106-07'55"W	2
NOT IN WILDERNESS	SLATER LAKE	4E3-020	39-49'12"N	105-42'08"W	2
NOT IN WILDERNESS	SNOWBANK LAKE	4E1-031	40-14'25"N	105-38'40"W	2
NOT IN WILDERNESS	SNOWDRIFT LAKE	4E1-058	40-18'25"N	105-44'04"W	2
NOT IN WILDERNESS	SOUTH COLONY LAKES (N)	4E2-049	37-58'08"N	105-34'10"W	2
NOT IN WILDERNESS	SOUTH MESA LAKE	4E3-023	39-02'30"N	108-05'30"W	2
NOT IN WILDERNESS	SPECTACLE LAKES (NW)	4E1-012	40-27'04"N	105-40'30"W	2
NOT IN WILDERNESS	STAPP LAKES (LG.NE)	4E2-015	40-07'10"N	105-32'28"W	2
NOT IN WILDERNESS	SUMMIT LAKE	4E2-060	40-32'43"N	106-40'55"W	2
NOT IN WILDERNESS	TIMBER LAKE	4E1-057	40-22'27"N	105-47'45"W	2
NOT IN WILDERNESS	TRIPLE LAKES (WESTERN)	4E1-044	40-01'50"N	105-37'15"W	2
NOT IN WILDERNESS	TWIN LAKES (NW)	4E3-008	40-38'22"N	105-50'25"W	2
NOT IN WILDERNESS	TWO RIVERS LAKE	4E1-021	40-19'17"N	105-40'55"W	2
NOT IN WILDERNESS	UPPER BRUSH LAKE	4E2-045	38-12'28"N	105-42'48"W	2
NOT IN WILDERNESS	UPPER EGGLESTON LAKE	4E3-030	39-03'12"N	107-55'43"W	2
NOT IN WILDERNESS	WILLOW CRK LKS(SE)	4E2-056	37-58'57"N	105-35'32"W	2
		IDAHO			
GOSPEL HUMP	KELLY LAKES (WESTERN)	4C2-019	45-38'36"N	115-40'38"W	1
HELLS CANYON	SATAN LAKE	4C3-039	45-12'05"N	116-33'11"W	6
HELLS CANYON	TRIANGLE LAKE	4C3-061	45-19'14"N	116-33'48"W	6
RIVER OF NO RETURN	(NO NAME)	4C2-021	45-32'02"N	114-45'00"W	1
RIVER OF NO RETURN	CENTER CK. LAKES (WEST)	4C2-014	45-34'23"N	115-02'28"W	1
RIVER OF NO RETURN	CUTTHROAT LAKE	4C2-030	45-22'30"N	115-20'00"W	4
RIVER OF NO RETURN	DENNIS LAKES (MIDDLE)	4C2-053	45-32'17"N	114-52'40"W	1
RIVER OF NO RETURN	DOME LAKE	4C2-034	45-15'40"N	114-31'10"W	4

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		IDAHO			
RIVER OF NO RETURN	FALCONBERRY LAKE	4C2-041	44-45'07"N	114-45'33"W	4
RIVER OF NO RETURN	GOLDEN TROUT LAKE	4C2-036	45-06'40"N	114-31'15"W	4
RIVER OF NO RETURN	HARBOR LAKE	4C2-035	45-08'35"N	114-35'30"W	4
RIVER OF NO RETURN	MABLE LAKES (NORTHWEST)	4C3-045	44-27'26"N	115-09'22"W	4
RIVER OF NO RETURN	SKYHIGH LAKE	4C2-056	45-07'12"N	114-36'29"W	4
SAWTOOTH	(NO NAME)	4C1-042	44-00'50"N	114-59'56"W	4
SAWTOOTH	(NO NAME)	4C1-043	44-01'50"N	114-57'32"W	4
SAWTOOTH	(NO NAME)	4C1-044	44-00'06"N	114-55'20"W	4
SAWTOOTH	(NO NAME)	4C1-046	43-57'34"N	114-56'30"W	4
SAWTOOTH	(NO NAME)	4C1-047	43-56'10"N	114-59'53"W	4
SAWTOOTH	(NO NAME)	4C1-048	43-55'38"N	114-58'20"W	4
SAWTOOTH	(NO NAME)	4C1-049	43-54'52"N	114-58'09"W	4
SAWTOOTH	(NO NAME)	4C1-050	43-53'24"N	114-59'35"W	4
SAWTOOTH	(NO NAME)	4C1-058	43-56'23"N	114-59'48"W	4
SAWTOOTH	(NO NAME)	4C2-044	44-09'25"N	115-02'08"W	4
SAWTOOTH	(NO NAME)	4C2-046	44-05'15"N	114-59'35"W	4
SAWTOOTH	(NO NAME)	4C2-047	43-59'36"N	115-05'33"W	4
SAWTOOTH	(NO NAME)	4C2-048	43-56'26"N	115-05'28"W	4
SAWTOOTH	(NO NAME)	4C2-049	43-57'59"N	115-01'18"W	4
SAWTOOTH	ALPINE LAKE	4C2-051	44-02'06"N	115-08'40"W	4
SAWTOOTH	FARLEY LAKE	4C1-057	44-03'53"N	115-01'20"W	4
SAWTOOTH	UPPER BARON LAKE	4C1-045	43-58'46"N	114-55'50"W	4
SELWAY-BITTEROOT	(NO NAME)	4C2-045	44-04'40"N	115-01'45"W	4
SELWAY-BITTEROOT	(NO NAME)	4C1-026	45-57'31"N	114-24'35"W	1
SELWAY-BITTEROOT	BIG FOG LAKE	4C2-010	46-17'33"N	115-06'40"W	1
SELWAY-BITTEROOT	BRUSHY FORK LAKE	4C2-011	46-08'52"N	115-10'54"W	1
SELWAY-BITTEROOT	BUCK LAKE	4C1-025	45-58'50"N	114-34'15"W	1
SELWAY-BITTEROOT	COLT LAKE	4C2-013	45-59'08"N	115-06'58"W	1
SELWAY-BITTEROOT	EAGLE MOUNTAIN LAKE	4C1-056	46-24'06"N	114-43'39"W	1
SELWAY-BITTEROOT	ELIZABETH LAKE	4C2-009	46-20'30"N	115-06'45"W	1
SELWAY-BITTEROOT	HIDDEN LAKE	4C2-052	46-11'54"N	115-12'33"W	1
SELWAY-BITTEROOT	JEANETTE LAKE	4C2-012	46-21'00"N	114-31'00"W	1
SELWAY-BITTEROOT	KIDNEY LAKE	4C1-015	46-18'20"N	114-34'45"W	1
SELWAY-BITTEROOT	MAY LAKE	4C1-032	46-20'57"N	114-43'30"W	1
SELWAY-BITTEROOT	PARACHUTE LAKE	4C1-033	46-15'30"N	114-51'58"W	1
SELWAY-BITTEROOT	PARK LAKE	4C1-013	46-24'55"N	114-25'15"W	1
SELWAY-BITTEROOT	SIAH LAKE	4C1-018	46-10'37"N	114-37'23"W	1
SELWAY-BITTEROOT	WHITE CAP LAKES (CENTER)	4C1-059	46-31'23"N	114-26'37"W	1
NOT IN WILDERNESS	(NO NAME)	4C1-028	45-55'00"N	114-27'05"W	1
NOT IN WILDERNESS	(NO NAME)	4C1-031	46-24'43"N	114-42'24"W	1
NOT IN WILDERNESS	(NO NAME)	4C2-028	45-07'09"N	116-05'41"W	4
NOT IN WILDERNESS	(NO NAME)	4C3-044	44-30'28'N	115-07'30"W	4
NOT IN WILDERNESS	(NO NAME)	4C3-048	44-01'27"N	114-37'32"W	4
NOT IN WILDERNESS	(NO NAME)	4C3-050	43-33'28"N	114-24'49"W	4
NOT IN WILDERNESS	(NO NAME)	4C3-054	44-45'07"N	116-02'35"W	4
NOT IN WILDERNESS	BEAR CREEK LAKE	4C3-057	48-40'02"N	116-03'31"W	1
NOT IN WILDERNESS	BLACKMARE LAKE	4C3-049	43-59'36"N	113-30'42"W	4
NOT IN WILDERNESS	BLOOM LAKE	4C2-033	44-46'00"N	115-48'10"W	4
NOT IN WILDERNESS	BOX LAKE	4C2-002	48-30'08"N	116-25'00"W	1
NOT IN WILDERNESS	BUSTER LAKE	4C2-029	45-01'11"N	115-58'45"W	4
NOT IN WILDERNESS	CHAMPION LAKES (LG.SOUTH)	4C3-046	44-26'22"N	114-24'52"W	4
NOT IN WILDERNESS	COOKS LAKE	4C3-047	44-00'00"N	114-41'06"W	4
NOT IN WILDERNESS	COW LAKE	4C1-004	48-41'57"N	116-35'11"W	1
NOT IN WILDERNESS	CUTOFF LAKE	4C2-060	45-01'45"N	115-49'43"W	4
NOT IN WILDERNESS	FAULT LAKE	4C1-051	48-51'12"N	116-40'53"W	1
NOT IN WILDERNESS	FISH LAKE	4C1-005	48-33'53"N	116-41'44"	1
NOT IN WILDERNESS	FROG LAKE	4C2-004	47-06'04"N	115-57'45"W	1
NOT IN WILDERNESS	GIBSON LAKES (LG. SE)	4C2-027	45-09'36"N	116-11'53"W	4
		4D3-040	42-02'12"N	111-37'47"W	4

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		IDAHO			
NOT IN WILDERNESS	HAT CREEK LAKES (SE)	4C3-042	44-52'39"N	114-12'14"W	4
NOT IN WILDERNESS	KELLY LAKE	4C2-043	44-16'52"N	115-09'27"W	4
NOT IN WILDERNESS	KENT LAKE	4C1-003	48-43'34"N	116-40'15"W	1
NOT IN WILDERNESS	LOOKOUT LAKE	4C1-001	48-46'45"N	116-46'43"W	1
NOT IN WILDERNESS	MAKI LAKE	4C2-031	44-58'24"N	115-54'53"W	4
NOT IN WILDERNESS	MALONY LAKE	4C2-032	44-52'29"N	115-54'00"W	4
NOT IN WILDERNESS	MARSH LAKE	4C2-001	48-56'30"N	116-47'15"W	1
NOT IN WILDERNESS	MINER LAKE	4C2-058	43-45'33"N	114-39'54"W	4
NOT IN WILDERNESS	NORTHBOUND LAKE	4C2-006	46-56'25"N	115-34'09"W	1
NOT IN WILDERNESS	PONY LAKE	4C3-040	45-11'04"N	114-06'43"W	4
NOT IN WILDERNESS	ROMAN NOSE LAKES(N)	4C1-053	48-38'27"N	116-34'58"W	1
NOT IN WILDERNESS	ROSS FORK LKS.(LG.CENTER)	4C2-050	43-45'11"N	115-01'53"W	4
NOT IN WILDERNESS	ROUND LAKE	4C3-064	48-09'43"N	116-38'15"W	1
NOT IN WILDERNESS	SMITH LAKE	4C1-007	48-25'11"N	116-06'10"W	1
NOT IN WILDERNESS	SNOW LAKE	4C1-006	48-38'35"N	116-35'38"W	1
NOT IN WILDERNESS	SPRUCE CRK. LAKES (LG. S)	4C1-009	46-34'07"N	114-23'25"W	1
NOT IN WILDERNESS	UPPER PALISADES L.	4D3-069	43-26'03"N	111-07'15"W	4
NOT IN WILDERNESS	UPPER STEVENS LAKE	4C2-003	47-25'41"N	115-45'41"W	1
		MONTANA			
ABSAROKA-BEARTOOTH	(NO NAME)	4D1-001	45-03'58"N	109-46'02"W	1
ABSAROKA-BEARTOOTH	(NO NAME)	4D2-004	45-10'27"N	109-45'17"W	1
ABSAROKA-BEARTOOTH	(NO NAME)	4D2-007	45-04'04"N	109-44'45"W	1
ABSAROKA-BEARTOOTH	(NO NAME)	4D2-050	45-16'12"N	110-06'07"W	1
ABSAROKA-BEARTOOTH	(NO NAME)	4D2-057	45-06'31"N	109-42'50"W	1
ABSAROKA-BEARTOOTH	(NO NAME)	4D3-004	45-15'32"N	110-09'52"W	1
ABSAROKA-BEARTOOTH	(NO NAME)	4D3-005	45-18'03"N	109-48'17"W	1
ABSAROKA-BEARTOOTH	(NO NAME)	4D3-006	45-10'42"N	110-05'54"W	1
ABSAROKA-BEARTOOTH	(NO NAME)	4D3-010	45-01'34"N	109-38'58"W	1
ABSAROKA-BEARTOOTH	(NO NAME)	4D3-067	45-14'42"N	109-51'15"W	1
ABSAROKA-BEARTOOTH	BLACK CANYON LAKE	4D2-008	45-04'10"N	109-32'00"W	1
ABSAROKA-BEARTOOTH	ELEPHANT LAKE	4D2-005	45-07'25"N	109-39'30"W	1
ABSAROKA-BEARTOOTH	FIRE LAKE	4D3-002	45-22'52"N	110-30'31"W	1
ABSAROKA-BEARTOOTH	FLAT ROCK LAKE	4D1-002	45-04'00"N	109-38'15"W	1
ABSAROKA-BEARTOOTH	LOST LAKE	4D3-007	45-11'40"N	109-41'15"W	1
ABSAROKA-BEARTOOTH	RAINBOW LAKES (3 FROM NE)	4D3-056	45-16'27"N	110-07'15"W	1
ABSAROKA-BEARTOOTH	RED ROCK LAKES (EASTERN)	4D2-006	45-04'55"N	109-44'00"W	1
ANACONDA-PINTLER	CARPP LAKE	4C2-015	46-00'44"N	113-27'09"W	1
ANACONDA-PINTLER	HOPE LAKE	4C2-018	45-51'25"N	113-36'11"W	1
ANACONDA-PINTLER	RAINBOW LAKE	4C2-017	45-57'28"N	113-27'06"W	1
CABINET MOUNTAIN	SKY LAKES (LG. ONE)	4C3-014	48-19'12"N	115-42'50"W	1
GREAT BEAR	(NO NAME)	4C3-016	48-12'51"N	113-29'42"W	1
LEE METCALF	(NO NAME)	4D3-011	44-56'46"N	111-28'58"W	1
LEE METCALF	BLUE DANUBE LAKE	4D1-062	44-52'37"N	111-26'20"W	1
LEE METCALF	TRIPLE LAKES(LARGEST)	4D1-061	44-52'44"N	111-25'57"W	1
MISSION MOUNTAINS	(NO NAME)	4C3-022	47-35'24"N	113-55'10"W	1
MISSION MOUNTAINS	(NO NAME)	4C3-055	47-35'00"N	113-54'07"W	1
RATTLESNAKE	(NO NAME)	4C3-059	47-05'23"N	113-54'34"W	1
RATTLESNAKE	FARMERS LAKES (NORTH)	4C3-031	47-00'30"N	113-54'22"W	1
SELWAY-BITTEROOT	(NO NAME)	4C1-023	46-01'52"N	114-24'07"W	1
SELWAY-BITTEROOT	(NO NAME)	4C1-024	46-00'37"N	114-22'37"W	1
SELWAY-BITTEROOT	(NO NAME)	4C1-027	45-48'15"N	114-31'45"W	1
SELWAY-BITTEROOT	(NO NAME)	4C1-052	45-56'45"N	114-22'10"W	1
SELWAY-BITTEROOT	(NO NAME)	4C1-060	46-04'19"N	114-27'43"W	1
SELWAY-BITTEROOT	BEAR LAKE	4C1-014	46-26'08"N	114-21'07"W	1

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		MONTANA			
SELWAY-BITTEROOT	BLODGETT LAKE	4C1-017	46-15'00"N	114-27'15"W	1
SELWAY-BITTEROOT	CAVE LAKE	4C1-030	45-54'12"N	114-17'54"W	1
SELWAY-BITTEROOT	FISH LAKE	4C1-021	46-06'13"N	114-27'30"W	1
SELWAY-BITTEROOT	HEINRICH LAKE	4C1-016	46-18'49"N	114-25'08"W	1
SELWAY-BITTEROOT	HOLLOWAY LAKE	4C1-010	46-38'09"N	114-15'42"W	1
SELWAY-BITTEROOT	LITTLE CARLTON LAKE	4C1-011	46-40'46"N	114-12'50"W	1
SELWAY-BITTEROOT	MIDDLE FK. LAKES (WEST)	4C1-012	46-33'03"N	114-19'37"W	1
SELWAY-BITTEROOT	MILEPOST LAKE	4C1-022	46-02'25"N	114-29'59"W	1
SELWAY-BITTEROOT	SEARS LAKE	4C1-055	46-17'58"N	114-22'12"W	1
SELWAY-BITTEROOT	TRAPPER LAKE	4C1-029	45-54'32"N	114-21'29"W	1
NOT IN WILDERNESS	(NO NAME)	4C1-008	46-43'48"N	114-46'30"W	1
NOT IN WILDERNESS	(NO NAME)	4C2-016	46-02'52"N	113-12'20"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-002	48-56'34"N	113-43'00"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-004	48-49'10"N	113-56'22"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-007	48-48'57"N	113-24'42"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-008	48-40'00"N	114-46'52"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-020	47-45'22"N	113-48'43"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-021	47-38'23"N	113-38'13"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-023	47-32'12"N	115-10'47"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-025	47-28'00"N	113-43'10"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-028	47-19'49"N	113-36'28"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-029	47-15'28"N	113-34'02"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-030	47-07'38"N	113-28'23"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-033	46-31'37"N	112-34'44"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-034	46-21'50"N	113-02'05"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-037	45-47'52"N	113-35'57"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-051	48-37'58"N	113-18'03"W	1
NOT IN WILDERNESS	(NO NAME)	4C3-063	48-52'30"N	113-25'52"W	1
NOT IN WILDERNESS	(NO NAME)	4D3-001	45-28'52"N	110-58'00"W	1
NOT IN WILDERNESS	(NO NAME)	4D3-003	45-21'07"N	109-43'15"W	1
NOT IN WILDERNESS	(NO NAME)	4D3-051	45-27'40"N	111-26'32"W	1
NOT IN WILDERNESS	(NO NAME)	4D3-066	44-54'04"N	112-11'13"W	1
NOT IN WILDERNESS	ACORN LAKE	4C3-024	47-28'33"N	115-08'51"W	1
NOT IN WILDERNESS	AJAX LAKE	4C2-037	45-19'46"N	113-43'35"W	1
NOT IN WILDERNESS	BIG HAWK LAKE	4C3-017	48-05'51"N	113-51'30"W	1
NOT IN WILDERNESS	BLUE LAKE	4D2-062	46-02'01"N	110-17'19"W	1
NOT IN WILDERNESS	BOBCAT LAKES (NW)	4C2-022	45-37'14"N	113-13'34"W	1
NOT IN WILDERNESS	BONANZA LAKES (SOUTHERN)	4C2-005	47-05'10"N	115-07'54"W	1
NOT IN WILDERNESS	BUCK LAKE	4C3-053	47-17'04"N	113-46'40"W	1
NOT IN WILDERNESS	BUFFALO LAKES (LG.CENTER)	4C3-052	48-23'30"N	113-14'14"W	1
NOT IN WILDERNESS	BURGESS LAKE	4C3-027	47-19'58"N	114-39'43"W	1
NOT IN WILDERNESS	CANYON LAKE	4C2-023	45-35'10"N	112-59'41"W	1
NOT IN WILDERNESS	CARLTON LAKE	4C1-062	46-41'01"N	114-13'12"W	1
NOT IN WILDERNESS	CHAIN LAKES (2 FROM EAST)	4C3-006	48-46'32"N	114-34'07"W	1
NOT IN WILDERNESS	COBALT LAKE	4C3-013	48-26'04"N	113-25'30"W	1
NOT IN WILDERNESS	CRYSTAL LAKE	4C3-056	46-20'15"N	113-09'54"W	1
NOT IN WILDERNESS	DEEP CREEK LAKE	4C2-059	47-02'36"N	115-00'15"W	1
NOT IN WILDERNESS	DEERHEAD LAKE	4C2-057	45-26'14"N	112-54'55"W	1
NOT IN WILDERNESS	DIAMOND LAKE	4D2-001	46-03'37"N	110-22'00"W	1
NOT IN WILDERNESS	ELK LAKE	4C3-019	47-53'58"N	115-23'54"W	1
NOT IN WILDERNESS	EMERALD LAKE	4D2-061	45-24'48"N	110-55'33"W	1
NOT IN WILDERNESS	ESTLER LAKE	4C2-026	45-22'25"N	112-58'37"W	1
NOT IN WILDERNESS	FEATHER WOMAN LAKE	4C3-010	48-37'04"N	113-46'38"W	1
NOT IN WILDERNESS	GLACIER LAKE	4C2-025	45-28'07"N	112-59'35"W	1
NOT IN WILDERNESS	GLENNS LAKE	4C3-062	48-54'10"N	113-47'30"W	1
NOT IN WILDERNESS	HARRISON LAKE	4C3-011	48-31'10"N	113-46'00"W	1
NOT IN WILDERNESS	HEART LAKE	4C2-007	46-56'57"N	114-58'15"W	1
NOT IN WILDERNESS	HEATHER LAKE	4D2-003	45-24'35"N	110-56'08"W	1

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		MONTANA			
NOT IN WILDERNESS	HOLLAND LAKE	4C3-026	47-27'00"N	113-35'45"W	1
NOT IN WILDERNESS	HOPKINS LAKE	4C2-024	45-27'46"N	113-02'14"W	1
NOT IN WILDERNESS	HUBBART RESERVOIR	4C3-058	47-56'00"N	114-44'30"W	1
NOT IN WILDERNESS	KEEP COOL LAKES (WESTERN)	4C3-032	47-00'18"N	112-36'20"W	1
NOT IN WILDERNESS	KIDNEY LAKE	4C1-020	46-09'03"N	114-17'02"W	1
NOT IN WILDERNESS	LAKE GENEVA	4C2-038	45-15'07"N	113-39'18"W	1
NOT IN WILDERNESS	LAKE OF THE ISLE	4C3-036	46-04'22"N	113-11'13"W	1
NOT IN WILDERNESS	LITTLE POZEGA LAKE	4C3-035	46-16'42"N	113-04'25"W	1
NOT IN WILDERNESS	LONG LAKE	4D3-009	45-04'55"N	109-54'40"W	1
NOT IN WILDERNESS	MUD LAKE	4C3-003	48-51'24"N	115-10'22"W	1
NOT IN WILDERNESS	SCHOOLHOUSE LAKE	4C3-012	48-25'07"N	115-51'02"W	1
NOT IN WILDERNESS	SCHOOLMARM LAKE	4C3-065	45-54'47"N	113-56'40"W	1
NOT IN WILDERNESS	STONER LAKE	4C3-060	47-28'12"N	113-43'47"W	1
NOT IN WILDERNESS	SURVEYOR LAKE	4C2-008	46-49'21"N	114-45'30"W	1
NOT IN WILDERNESS	THUNDER LAKE	4D2-063	46-02'02"N	110-17'08"W	1
NOT IN WILDERNESS	TWIN LAKES (LG.SOUTH)	4C1-019	46-09'15"N	114-29'45"W	1
NOT IN WILDERNESS	TWIN LAKES (SW)	4D2-058	46-02'33"N	110-18'50"W	1
NOT IN WILDERNESS	UPPER TWIN LAKE	4C1-061	46-09'44"N	114-30'00"W	1
		NEW MEXICO			
WHEELER PEAK	LOST LAKE	4E3-058	36-34'40"N	105-24'15"W	3
NOT IN WILDERNESS	BRANCH TANK	4E3-048	36-02'43"N	106-41'03"W	3
NOT IN WILDERNESS	STONE (BOULDER) LAKE	4E3-047	36-43'15"N	106-52'32"W	3
		NEVADA			
NOT IN WILDERNESS	(NO NAME)	4A3-033	38-59'48"N	119-56'20"W	5
NOT IN WILDERNESS	INCLINE LAKE	4A3-063	39-17'40"N	119-55'32"W	4
NOT IN WILDERNESS	MARLETTE RESERVOIR	4A3-030	39-10'22"N	119-55'15"W	4
		OREGON			
COLUMBIA	NORTH LAKE	4B3-009	45-38'33"N	121-45'25"W	6
DIAMOND PEAK	DIAMOND VIEW LAKE	4B2-005	43-31'42"N	122-04'15"W	6
EAGLE CAP	(NO NAME)	4C1-034	45-19'14"N	117-27'30"W	6
EAGLE CAP	JOHN HENRY LAKE	4C1-035	45-16'07"N	117-26'25"W	6
EAGLE CAP	LITTLE FRAZIER LAKE	4C1-040	45-09'06"N	117-16'01"W	6
EAGLE CAP	LONG LAKE	4C1-036	45-14'00"N	117-26'22"W	6
EAGLE CAP	POCKET LAKE	4C1-037	45-10'30"N	117-16'30"W	6
EAGLE CAP	RAZZ LAKE	4C1-038	45-12'45"N	117-16'39"W	6
EAGLE CAP	SWAMP LAKE	4C1-054	45-13'03"N	117-25'16"W	6
EAGLE CAP	TRAVERSE LAKE	4C1-039	45-07'14"N	117-26'20"W	6
MT. HOOD	BURNT LAKE	4B2-058	45-21'03"N	121-48'05"W	6
MT. JEFFERSON	BEAR LAKE	4B1-014	44-45'00"N	121-50'30"W	6
MT. JEFFERSON	MARTIN LAKE	4B2-011	44-27'28"N	121-50'22"W	6
MT. WASHINGTON	KUITAN LAKE	4B2-055	44-16'38"N	121-56'38"W	6
SKY LAKES	(NO NAME)	4B2-002	42-31'40"N	122-14'23"W	6
SKY LAKES	GRASS LAKE	4B2-003	42-39'45"N	122-13'00"W	6
SKY LAKES	ISHERWOOD LAKE	4B1-002	42-34'22"N	122-12'05"W	6
SKY LAKES	LAKE NOTASHA	4B1-060	42-34'05"N	122-12'08"W	6
SKY LAKES	MC KEE LAKE	4B2-063	42-33'03"N	122-17'55"W	6

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		OREGON			
THREE SISTERS	(NO NAME)	4B1-007	43-53'00"N	121-58'30"W	6
THREE SISTERS	(NO NAME)	4B2-009	44-02'30"N	121-58'44"W	6
THREE SISTERS	CAMPERS LAKE	4B1-013	44-13'30"N	121-52'02"W	6
THREE SISTERS	CHAMBERS LAKES (S.WEST)	4B1-012	44-07'20"N	121-46'43"W	6
THREE SISTERS	EILEEN LAKE	4B1-064	44-08'20"N	121-50'54"W	6
THREE SISTERS	HELEN LAKE	4B1-054	43-48'54"N	122-01'02"W	6
THREE SISTERS	KRAG LAKE	4B1-010	43-57'41"N	121-53'20"W	6
THREE SISTERS	MERRILL LAKE	4B1-065	43-55'18"N	121-54'04"W	6
THREE SISTERS	PENN LAKE	4B1-009	43-57'07"N	121-55'08"W	6
THREE SISTERS	RAFT LAKE	4B1-008	43-48'21"N	121-54'20"W	6
WALDO LAKE	HARVEY LAKE	4B1-006	43-47'23"N	122-02'10"W	6
WALDO LAKE	MOOLACK LAKE	4B2-069	43-49'22"N	122-04'10"W	6
WALDO LAKE	WINCHESTER LAKE	4B2-007	43-49'12"N	122-06'20"W	6
NOT IN WILDERNESS	(NONAME)	4B3-051	45-11'00"N	122-22'50"W	6
NOT IN WILDERNESS	(NO NAME)	4B1-003	42-37'53"N	122-08'35"W	6
NOT IN WILDERNESS	(NO NAME)	4B1-005	43-41'12"N	122-01'22"W	6
NOT IN WILDERNESS	(NO NAME)	4B2-004	43-25'25"N	122-03'11"W	6
NOT IN WILDERNESS	(NO NAME)	4B2-006	43-41'10"N	122-07'53"W	6
NOT IN WILDERNESS	(NO NAME)	4B3-002	43-16'12"N	122-27'20"W	6
NOT IN WILDERNESS	ABERNETHY LAKE	4B3-003	43-36'10"N	122-06'00"W	6
NOT IN WILDERNESS	BLUE RIVER LAKE	4B3-004	44-10'32"N	122-18'18"W	6
NOT IN WILDERNESS	BREITENBUSH LAKE	4B1-056	44-46'10"N	121-46'40"W	6
NOT IN WILDERNESS	BULL RUN RES. NO.1	4B3-008	45-29'10"N	122-03'45"W	6
NOT IN WILDERNESS	CLEAR CREEK RES.	4C1-041	45-03'42"N	117-09'14"W	6
NOT IN WILDERNESS	CRABTREE LAKE	4B3-064	44-36'18"N	122-27'05"W	6
NOT IN WILDERNESS	CRESENT LAKE	4B3-066	43-28'45"N	121-59'00"W	6
NOT IN WILDERNESS	DETROIT LAKE	4B3-006	44-42'50"N	122-11'00"W	6
NOT IN WILDERNESS	ELK LAKE	4B2-012	44-49'25"N	122-07'00"W	6
NOT IN WILDERNESS	EMERALD LAKE	4B3-007	45-01'18"N	122-21'00"W	6
NOT IN WILDERNESS	FAY LAKE	4B3-005	44-30'38"N	121-58'30"W	6
NOT IN WILDERNESS	FISH LAKE	4B3-001	42-23'20"N	122-19'45"W	6
NOT IN WILDERNESS	GOODFELLOW LAKES (EAST)	4B2-015	45-25'30"N	121-57'15"W	6
NOT IN WILDERNESS	HEART LAKE	4B2-010	44-23'00"N	122-05'05"W	6
NOT IN WILDERNESS	HIDAWAY LAKE	4B2-013	45-07'18"N	121-58'00"W	6
NOT IN WILDERNESS	HOSMER LAKE	4B1-011	43-57'47"N	121-46'46"W	6
NOT IN WILDERNESS	LAKE APHIS	4B1-001	42-26'55"N	122-14'35"W	6
NOT IN WILDERNESS	LITTLE CULTUS LAKE	4B2-008	43-48'12"N	121-52'30"W	6
NOT IN WILDERNESS	LOST LAKE	4B1-016	45-29'21"N	121-49'15"W	6
NOT IN WILDERNESS	LOST LAKE	4C2-040	44-54'14"N	118-13'31"W	6
NOT IN WILDERNESS	LOWER LAKE	4B1-015	44-49'33"N	121-48'16"W	6
NOT IN WILDERNESS	MEEK LAKE	4B2-059	43-27'47"N	122-05'05"W	6
NOT IN WILDERNESS	MIRROR LAKE	4B2-014	45-17'50"N	121-47'30"W	6
NOT IN WILDERNESS	NIP&TUCK LAKES (NE)	4B1-063	43-23'18"N	122-00'28"W	6
NOT IN WILDERNESS	PINE CREEK RES.	4C2-055	44-49'26"N	118-04'52"W	6
NOT IN WILDERNESS	WINDY LAKES (2 FROM S)	4B1-004	43-25'20"N	122-04'30"W	6
		UTAH			
HIGH UINTAS	(NO NAME)	4D1-044	40-50'03"N	110-14'15"W	4
HIGH UINTAS	(NO NAME)	4D1-045	40-49'30"N	110-04'40"W	4
HIGH UINTAS	(NO NAME)	4D1-052	40-48'25"N	110-23'58"W	4
HIGH UINTAS	(NO NAME)	4D2-039	40-40'15"N	110-16'30"W	4
HIGH UINTAS	ALLRED LAKE	4D2-053	40-44'22"N	110-18'02"W	4
HIGH UINTAS	BLUEBELL LAKE	4D2-038	40-41'45"N	110-29'10"W	4
HIGH UINTAS	CLIFF LAKE	4D1-043	40-47'30"N	110-24'25"W	4
HIGH UINTAS	DEAN LAKE	4D2-054	40-40'43"N	110-45'39"W	4
HIGH UINTAS	DOLLAR LAKE	4D2-031	40-49'40"N	110-22'30"W	4

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		UTAH			
HIGH UINTAS	MARGIE LAKE	4D1-042	40-43'00"N	110-46'10"W	4
HIGH UINTAS	MILK LAKE	4D1-047	40-43'15"N	110-23'30"W	4
HIGH UINTAS	PHINNEY LAKE	4D2-037	40-43'10"N	110-39'50"W	4
HIGH UINTAS	PINE ISLAND LAKE	4D2-055	40-38'25"N	110-49'19"W	4
HIGH UINTAS	PINTO LAKE	4D2-036	40-39'40"N	110-48'30"W	4
HIGH UINTAS	SHADOW LAKE	4D3-072	40-37'12"N	110-48'00"W	4
LONE PEAK	LAKE HARDY	4D3-046	40-31'27"N	111-43'57"W	4
NOT IN WILDERNESS	(NO NAME)	4D1-040	40-40'00"N	111-04'34"W	4
NOT IN WILDERNESS	(NO NAME)	4D1-048	40-46'38"N	110-06'40"W	4
NOT IN WILDERNESS	(NO NAME)	4D1-050	40-43'10"N	109-49'15"W	4
NOT IN WILDERNESS	(NO NAME)	4D2-033	40-48'30"N	109-51'50"W	4
NOT IN WILDERNESS	(NO NAME)	4D2-040	40-43'20"N	110-04'30"W	4
NOT IN WILDERNESS	(NO NAME)	4D2-041	40-34'15"N	110-56'40"W	4
NOT IN WILDERNESS	ARTA LAKE	4D3-041	40-56'07"N	110-37'18"W	4
NOT IN WILDERNESS	CLEVELAND LAKE	4D3-045	40-35'00"N	110-47'25"W	4
NOT IN WILDERNESS	DUCK LAKE	4D2-032	40-45'45"N	110-06'40"W	4
NOT IN WILDERNESS	GRASSY LAKES (LG. S)	4D3-043	40-54'41"N	110-32'12"W	4
NOT IN WILDERNESS	KIBAH LAKES (SOUTHWEST)	4D3-059	40-56'30"N	110-51'55"W	4
NOT IN WILDERNESS	RHOADS LAKE	4D1-049	40-43'05"N	109-56'40"W	4
NOT IN WILDERNESS	STAR LAKE	4D2-034	40-44'04"N	111-01'52"W	4
NOT IN WILDERNESS	STEAM MILL LAKE	4D2-035	40-41'30"N	110-56'45"W	4
NOT IN WILDERNESS	TONY GROVE LAKE	4D3-071	41-56'39"N	111-38'30"W	4
NOT IN WILDERNESS	TRIAL LAKE	4D3-050	41-53'36"N	111-38'35"W	4
NOT IN WILDERNESS	TWIN LAKES RESERVOIR	4D1-041	40-41'00"N	110-57'15"W	4
NOT IN WILDERNESS	WEYMAN LAKES (WESTERN)	4D3-053	40-35'53"N	111-35'52"W	4
		4D1-046	40-48'38"N	109-57'40"W	4
		WASHINGTON			
ALPINE LAKES	(NO NAME)	4B1-037	47-38'12"N	121-07'15"W	6
ALPINE LAKES	AL LAKE	4B1-067	47-34'55"N	121-15'38"W	6
ALPINE LAKES	BEAR LAKE	4B1-027	47-34'30"N	121-23'45"W	6
ALPINE LAKES	BOB LAKE	4B1-038	47-35'24"N	121-03'47"W	6
ALPINE LAKES	BONNIE LAKE	4B1-029	47-33'57"N	121-16'15"W	6
ALPINE LAKES	CIRCLE LAKE	4B1-030	47-33'05"N	121-09'45"W	6
ALPINE LAKES	COLCHUCK LAKE	4B1-024	47-29'30"N	120-50'00"W	6
ALPINE LAKES	COUGAR LAKE	4B1-066	47-36'05"N	121-31'40"W	6
ALPINE LAKES	CRYSTAL LAKE	4B1-068	47-28'28"N	120-48'05"W	6
ALPINE LAKES	DEER LAKE	4B1-052	47-34'15"N	121-24'00"W	6
ALPINE LAKES	DOELLE LAKES (EASTERN)	4B2-034	47-41'35"N	121-00'05"W	6
ALPINE LAKES	HYAS LAKE	4B1-036	47-34'30"N	121-07'40"W	6
ALPINE LAKES	LAKE IVANHOE	4B1-055	47-32'02"N	121-14'15"W	6
ALPINE LAKES	NAZANNE LAKE	4B1-034	47-35'45"N	121-17'25"W	6
ALPINE LAKES	PARADISE LAKES (NORTHERN)	4B1-032	47-39'20"N	121-30'20"W	6
ALPINE LAKES	RACHEL LAKE	4B1-022	47-25'18"N	121-19'48"W	6
ALPINE LAKES	RAMPART LAKES (SOUTH)	4B1-057	47-24'57"N	121-20'20"W	6
ALPINE LAKES	SNOW LAKES (WESTERN)	4B1-025	47-28'55"N	120-45'22"W	6
ALPINE LAKES	SQUARE LAKE	4B1-061	47-38'45"N	121-07'10"W	6
ALPINE LAKES	TROUT LAKE	4B1-031	47-33'27"N	120-54'25"W	6
BOULDER RIVER	SADDLE LAKE	4B2-051	48-10'44"N	121-45'20"W	6
BUCKHORN	(NO NAME)	4B3-032	47-50'23"N	123-11'18"W	6
CLEARWATER	SUMMIT LAKE	4B2-064	47-02'22"N	121-49'50"W	6
GLACIER PEAK	(NO NAME)	4B2-047	48-24'36"N	121-04'43"W	6
GLACIER PEAK	AIRPLANE LAKE	4B1-053	48-00'10"N	121-00'20"W	6
GLACIER PEAK	CANYON LAKE	4B1-058	48-14'48"N	120-59'40"W	6
GLACIER PEAK	LAKE NO. 2	4B2-046	48-28'10"N	121-19'44"W	6

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		WASHINGTON			
GLACIER PEAK	LARCH LAKES (WESTERN)	4B1-042	48-03'48"N	120-44'15"W	6
GLACIER PEAK	LYMAN LAKE	4B1-043	48-11'30"N	120-54'30"W	6
GLACIER PEAK	PEAR LAKE	4B2-044	48-19'40"N	121-19'13"W	6
GLACIER PEAK	SULPHUR MTN LAKE	4B2-043	48-14'45"N	121-08'15"W	6
GLACIER PEAK	TWIN LAKES (EASTERN)	4B1-044	48-12'22"N	121-11'31"W	6
GOAT ROCKS	SUPRISE LAKE	4B3-013	46-28'10"N	121-21'33"W	6
HENRY M. JACKSON	HEATHER LAKE	4B1-041	47-51'30"N	121-07'35"W	6
HENRY M. JACKSON	JOAN LAKE	4B1-062	47-47'32"N	121-11'34"W	6
INDIAN HEAVEN	(NO NAME)	4B2-016	46-01'20"N	121-49'47"W	6
LAKE CHELAN-SAWTOOTH	(NO NAME)	4B1-045	48-14'28"N	120-18'55"W	6
LAKE CHELAN-SAWTOOTH	WILLIAMS LAKE	4B1-070	48-22'20"N	120-30'55"W	6
MOUNT BAKER	HAYES LAKE	4B1-049	48-51'25"N	121-43'11"W	6
NOISY DIOBSUD	WATSON LAKES (WEST)	4B2-068	48-40'00"N	121-35'22"W	6
PASAYTEN	(NO NAME)	4B3-046	48-57'45"N	120-52'50"W	6
PASAYTEN	BLACK LAKE	4B3-050	48-49'45"N	120-12'25"W	6
PASAYTEN	JERRY LAKES (NORTH)	4B3-044	48-45'40"N	120-55'05"W	6
PASAYTEN	LAKE OF THE PINES	4B3-047	48-52'54"N	120-42'40"W	6
PASAYTEN	LEASE LAKE	4B3-052	48-50'49"N	120-33'30"W	6
PASAYTEN	SHEEP LAKE	4B3-049	48-58'22"N	120-22'40"W	6
PASAYTEN	WHITE LAKES (NORTH)	4B3-048	48-54'33"N	120-32'55"W	6
WILLIAM O. DOUGLAS	AMERICAN LAKE	4B2-023	46-49'05"N	121-27'29"W	6
WILLIAM O. DOUGLAS	DEER LAKE	4B2-057	46-39'03"N	121-24'38"W	6
WILLIAM O. DOUGLAS	DUMBBELL LAKE	4B2-021	46-41'30"N	121-22'45"W	6
WILLIAM O. DOUGLAS	PEAR LAKE	4B2-062	46-44'20"N	121-18'50"W	6
WILLIAM O. DOUGLAS	SHELLROCK LAKE	4B2-022	46-41'05"N	121-20'40"W	6
NOT IN WILDERNESS	(NO NAME)	4B2-025	47-13'40"N	122-58'25"W	6
NOT IN WILDERNESS	(NO NAME)	4B2-032	47-41'02"N	121-44'28"W	6
NOT IN WILDERNESS	(NO NAME)	4B2-037	47-52'01"N	121-33'25"W	6
NOT IN WILDERNESS	(NO NAME)	4B2-042	48-09'48"N	121-55'58"W	6
NOT IN WILDERNESS	(NO NAME)	4B2-045	48-25'30"N	121-49'08"W	6
NOT IN WILDERNESS	(NO NAME)	4B2-049	48-36'05"N	120-56'35"W	6
NOT IN WILDERNESS	(NO NAME)	4B2-065	46-06'30"N	121-46'04"W	6
NOT IN WILDERNESS	(NO NAME)	4B3-023	47-32'30"N	122-54'38"W	6
NOT IN WILDERNESS	(NO NAME)	4B3-027	47-35'05"N	121-50'45"W	6
NOT IN WILDERNESS	(NO NAME)	4B3-028	47-38'52"N	121-46'45"W	6
NOT IN WILDERNESS	(NO NAME)	4B3-030	47-41'45"N	121-58'32"W	6
NOT IN WILDERNESS	(NO NAME)	4B3-031	47-42'55"N	121-52'00"W	6
NOT IN WILDERNESS	(NO NAME)	4B3-056	47-39'33"N	123-29'20"W	6
NOT IN WILDERNESS	(NO NAME)	4B3-065	47-41'38"N	121-58'22"W	6
NOT IN WILDERNESS	(NO NAME)	4B3-067	48-42'30"N	122-26'20"W	6
NOT IN WILDERNESS	ANNETTE LAKE	4C3-015	48-16'18"N	117-08'55"W	1
NOT IN WILDERNESS	BAKER LAKE	4B3-019	47-21'35"N	121-28'20"W	6
NOT IN WILDERNESS	BATTALION LAKE	4B1-019	47-21'06"N	121-18'02"W	6
NOT IN WILDERNESS	BERDEEN LAKE	4B2-060	48-20'45"N	120-47'13"W	6
NOT IN WILDERNESS	BOULDER LAKE	4B1-048	48-43'00"N	121-27'45"W	6
NOT IN WILDERNESS	BOYLE LAKE	4B3-063	47-58'35"N	123-44'53"W	6
NOT IN WILDERNESS	CALLIGAN LAKE	4B2-029	47-35'51"N	121-45'22"W	6
NOT IN WILDERNESS	CAMP LAKE	4B2-066	47-36'20"N	121-40'00"W	6
NOT IN WILDERNESS	CASKEY LAKE	4B3-020	47-18'50"N	120-52'47"W	6
NOT IN WILDERNESS	CATFISH LAKE	4B3-053	48-24'07"N	121-34'25"W	6
NOT IN WILDERNESS	CEDAR PONDS LAKE	4B2-026	47-22'00"N	122-50'25"W	6
NOT IN WILDERNESS	CHAIN LAKE	4B3-034	47-48'20"N	121-48'15"W	6
NOT IN WILDERNESS	CHAMBERS LAKE	4B3-036	47-54'15"N	121-58'10"W	6
NOT IN WILDERNESS	CHENUIS LAKES (SOUTHERN)	4B2-019	46-28'00"N	121-32'00"W	6
NOT IN WILDERNESS	COPPER LAKE	4B1-018	46-58'17"N	121-46'42"W	6
NOT IN WILDERNESS	CORA LAKE	4B2-041	48-01'55"N	121-32'15"W	6
NOT IN WILDERNESS	COUNCIL LAKE	4B3-015	46-41'20"N	121-53'19"W	6
		4B2-018	46-16'00"N	121-37'40"W	6

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		WASHINGTON			
NOT IN WILDERNESS	DAY LAKE	4B3-040	48-23'58"N	121-57'30"W	6
NOT IN WILDERNESS	DEADWOOD LAKES (SOUTH)	4B2-024	46-53'12"N	121-31'15"W	6
NOT IN WILDERNESS	DIABLO LAKE	4B2-050	48-42'45"N	121-06'45"W	6
NOT IN WILDERNESS	DOUBTFUL LAKE	4B1-046	48-28'27"N	121-02'47"W	6
NOT IN WILDERNESS	DUCK LAKE	4B3-014	46-39'48"N	122-19'40"W	6
NOT IN WILDERNESS	GOLDEN LAKES (LARGEST)	4B1-017	46-53'20"N	121-53'55"W	6
NOT IN WILDERNESS	GOLDEN LAKES (SW)	4B1-069	46-53'08"N	121-54'23"W	6
NOT IN WILDERNESS	GRANITE LAKES (NORTHERN)	4B2-028	47-27'20"N	121-36'52"W	6
NOT IN WILDERNESS	H&H RESERVOIR NO. 1	4B3-060	47-19'57"N	120-23'50"W	6
NOT IN WILDERNESS	HARTS SWAMP	4B3-033	47-46'32"N	121-56'00"W	6
NOT IN WILDERNESS	HIDDEN LAKE	4B2-070	48-29'45"N	121-11'15"W	6
NOT IN WILDERNESS	HOH LAKE	4B3-035	47-53'57"N	123-47'05"W	6
NOT IN WILDERNESS	HORSESHOE SLOUGH	4B3-026	47-37'25"N	121-55'20"W	6
NOT IN WILDERNESS	HUGHES LAKE	4B2-067	47-57'57"N	121-53'17"W	6
NOT IN WILDERNESS	HULL LAKE	4B3-068	47-39'55"N	121-47'50"W	6
NOT IN WILDERNESS	JASON LAKES (SOUTHERN)	4B2-035	47-42'55"N	120-53'25"W	6
NOT IN WILDERNESS	LAKE ALLEN	4B3-057	46-45'54"N	121-53'30"W	6
NOT IN WILDERNESS	LAKE ARMSTRONG	4B3-054	47-35'00"N	123-01'11"W	6
NOT IN WILDERNESS	LAKE CHAPLAIN	4B3-038	47-57'45"N	121-50'45"W	6
NOT IN WILDERNESS	LAKE JULIA	4B2-056	48-03'58"N	121-52'28"W	6
NOT IN WILDERNESS	LAKE JULIUS	4B2-053	47-44'12"N	120-52'30"W	6
NOT IN WILDERNESS	LAKE SERENE	4B2-036	47-47'00"N	121-34'15"W	6
NOT IN WILDERNESS	LAKE SHERRY	4C3-009	48-36'34"N	117-32'33"W	6
NOT IN WILDERNESS	LAMONT LAKE	4B1-047	48-29'50"N	120-31'27"W	6
NOT IN WILDERNESS	LE CONTE LAKE	4B3-055	46-22'55"N	121-24'05"W	6
NOT IN WILDERNESS	LITTLE LAKE	4B3-039	48-14'12"N	122-00'02"W	6
NOT IN WILDERNESS	LOST LAKE	4C3-005	48-49'18"N	117-26'17"W	6
NOT IN WILDERNESS	LUNCH LAKE	4B3-061	47-54'57"N	123-46'55"W	6
NOT IN WILDERNESS	MAD LAKE	4B2-039	47-56'03"N	120-39'10"W	6
NOT IN WILDERNESS	MATTHEWS LAKE	4B2-054	47-28'05"N	122-41'20"W	6
NOT IN WILDERNESS	MERRILL LAKE	4B3-011	46-05'35"N	122-19'15"W	6
NOT IN WILDERNESS	OAK PATCH LAKE	4B3-022	47-28'37"N	122-54'52"W	6
NOT IN WILDERNESS	OLALLIE LAKE	4B1-020	47-25'20"N	121-30'35"W	6
NOT IN WILDERNESS	SAMISH LAKE	4B3-041	48-40'00"N	122-23'00"W	6
NOT IN WILDERNESS	SILVER LAKE	4B1-050	48-59'15"N	121-13'45"W	6
NOT IN WILDERNESS	SILVER LAKE	4B3-045	48-58'45"N	122-04'05"W	6
NOT IN WILDERNESS	SPIDER LAKE	4B1-059	47-26'55"N	121-34'15"W	6
NOT IN WILDERNESS	STIRRUP LAKE	4B3-018	47-17'44"N	121-25'23"W	6
NOT IN WILDERNESS	SUNSET LAKE	4B3-016	47-06'34"N	122-00'50"W	6
NOT IN WILDERNESS	TAPTO LAKES (EAST)	4B1-051	48-53'05"N	121-22'05"W	6
NOT IN WILDERNESS	TUSCOHATCHIE LAKE	4B1-021	47-26'00"N	121-28'35"W	6
NOT IN WILDERNESS	TWO LAKES (WESTERN)	4B3-012	46-22'06"N	121-27'53"W	6
NOT IN WILDERNESS	U LAKE	4B3-021	47-25'41"N	123-04'23"W	6
NOT IN WILDERNESS	WALLACE LAKE	4B3-037	47-54'15"N	121-40'30"W	6
NOT IN WILDERNESS	WICKS LAKE	4B2-027	47-27'20"N	122-42'16"W	6
NOT IN WILDERNESS	WING LAKE	4B2-048	48-31'03"N	120-48'18"W	6
		WYOMING			
BRIDGER	(NO NAME)	4D1-008	43-21'50"N	109-44'15"W	4
BRIDGER	(NO NAME)	4D1-013	43-14'45"N	109-42'00"W	4
BRIDGER	(NO NAME)	4D1-018	43-06'22"N	109-39'08"W	4
BRIDGER	(NO NAME)	4D1-019	43-04'38"N	109-36'47"W	4
BRIDGER	(NO NAME)	4D1-021	43-02'30"N	109-43'35"W	4
BRIDGER	(NO NAME)	4D1-053	43-14'20"N	109-42'20"W	4
BRIDGER	(NO NAME)	4D1-059	43-02'05"N	109-33'50"W	4
BRIDGER	(NO NAME)	4D2-018	42-56'52"N	109-38'58"W	4

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		WYOMING			
BRIDGER	(NO NAME)	4D2-020	42-56'00"N	109-31'55"W	4
BRIDGER	(NO NAME)	4D2-027	42-47'42"N	109-19'36"W	4
BRIDGER	(NO NAME)	4D2-059	42-52'35"N	109-28'55"W	4
BRIDGER	(NO NAME)	4D2-060	42-58'39"N	109-40'35"W	4
BRIDGER	BARNES LAKE	4D2-017	42-57'47"N	109-35'52"W	4
BRIDGER	BLUE LAKE	4D1-035	42-44'31"N	109-13'25"W	4
BRIDGER	BOBS LAKE	4D2-023	42-52'14"N	109-25'00"W	4
BRIDGER	BORUM LAKE	4D1-016	43-07'15"N	109-46'00"W	4
BRIDGER	BRIDGER LAKES (2 FROM NE)	4D1-017	43-04'53"N	109-43'15"W	4
BRIDGER	CRESENT LAKE	4D1-009	43-20'06"N	109-44'53"W	4
BRIDGER	CROSS LAKE	4D2-019	42-54'00"N	109-34'20"W	4
BRIDGER	DADS LAKE	4D1-057	43-21'54"N	109-43'45"W	4
BRIDGER	FULL MOON LAKE	4D2-022	42-52'30"N	109-27'43"W	4
BRIDGER	HALLS LAKE	4D1-058	42-56'17"N	109-24'47"W	4
BRIDGER	KEVIN LAKE	4D1-010	43-17'00"N	109-42'30"W	4
BRIDGER	LAKE GADSBY	4D2-013	43-15'30"N	109-52'07"W	4
BRIDGER	LITTLE DIVIDE LAKE	4D2-025	42-50'13"N	109-28'53"W	4
BRIDGER	LITTLE SENECA LAKE	4D1-022	43-04'00"N	109-39'05"W	4
BRIDGER	PALMER LAKE	4D2-014	43-08'15"N	109-49'05"W	4
BRIDGER	POSTON LAKE	4D2-028	42-44'22"N	109-20'05"W	4
BRIDGER	SHIRLEY LAKE	4D2-012	43-16'00"N	109-51'50"W	4
BRIDGER	SHOESTRING LAKE	4D1-028	42-56'45"N	109-25'30"W	4
BRIDGER	SPIDER LAKE	4D1-023	43-01'00"N	109-34'25"W	4
BRIDGER	UPPER SILVER LKS(E)	4D2-052	42-48'51"N	109-22'15"W	4
BRIDGER	VALLEY LAKE	4D2-021	42-55'50"N	109-28'40"W	4
BRIDGER	WARBONNET LAKE	4D2-026	42-49'05"N	109-23'27"W	4
CLOUD PEAK	(NO NAME)	4D2-044	44-26'42"N	107-11'15"W	2
CLOUD PEAK	(NO NAME)	4D2-045	44-23'35"N	107-11'00"W	2
CLOUD PEAK	(NO NAME)	4D2-046	44-21'07"N	107-12'11"W	2
CLOUD PEAK	(NO NAME)	4D2-051	44-23'11"N	107-12'32"W	2
CLOUD PEAK	DUNCAN LAKE	4D3-061	44-30'07"N	107-14'37"W	2
CLOUD PEAK	FIREHOLE LAKES (MIDDLE)	4D2-049	44-15'00"N	107-03'30"W	2
CLOUD PEAK	LOST LAKE	4D2-043	44-29'40"N	107-17'15"W	2
CLOUD PEAK	SAWTOOTH LAKES (SOUTHERN)	4D2-047	44-24'25"N	107-09'37"W	2
CLOUD PEAK	STULL LAKES (NORTHERN)	4D2-042	44-35'40"N	107-19'25"W	2
FITZPATRICK	(NO NAME)	4D1-011	43-16'25"N	109-38'53"W	2
FITZPATRICK	(NO NAME)	4D1-014	43-13'10"N	109-39'32"W	2
FITZPATRICK	(NO NAME)	4D1-020	43-05'07"N	109-30'15"W	2
FITZPATRICK	(NO NAME)	4D1-024	43-03'27"N	109-31'15"W	2
FITZPATRICK	BOONE LAKE	4D1-007	43-26'37"N	109-42'33"W	2
FITZPATRICK	MOOSE LAKE	4D1-015	43-13'15"N	109-30'50"W	2
GROS VENTRE	(NO NAME)	4D3-030	43-29'32"N	110-34'20"W	4
GROS VENTRE	(NO NAME)	4D3-033	43-20'20"N	110-13'50"W	4
GROS VENTRE	BOX LAKE	4D3-031	43-25'45"N	110-29'00"W	4
JEDIDIAH SMITH	HIDDEN LAKE	4D3-022	44-00'24"N	110-56'00"W	4
POPO AGIE	(NO NAME)	4D1-033	42-51'06"N	109-14'31"W	2
POPO AGIE	(NO NAME)	4D1-036	42-47'41"N	109-11'42"W	2
POPO AGIE	(NO NAME)	4D1-038	42-40'13"N	109-01'15"W	2
POPO AGIE	(NO NAME)	4D1-039	42-38'10"N	108-57'52"W	2
POPO AGIE	(NO NAME)	4D1-056	42-50'23"N	109-14'32"W	2
POPO AGIE	DUTCH OVEN LAKE	4D1-034	42-50'39"N	109-11'37"W	2
POPO AGIE	ICE LAKES (NORTHEAST)	4D1-037	42-43'15"N	109-05'00"W	2
POPO AGIE	STOUGH CREEK LAKES(LG NW)	4D1-051	42-39'22"N	109-01'10"W	2
TETON	FERRY LAKE	4D3-024	43-56'45"N	109-57'55"W	4
NOT IN WILDERNESS	(NO NAME)	4D1-003	44-58'45"N	109-33'40"W	2
NOT IN WILDERNESS	(NO NAME)	4D1-004	44-57'10"N	109-30'15"W	2
NOT IN WILDERNESS	(NO NAME)	4D1-006	44-38'25"N	110-22'40"W	1
NOT IN WILDERNESS	(NO NAME)	4D1-025	43-00'36"N	109-26'50"W	2

Table A-1. (contd).

WILDERNESS NAME	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE	FS REGION
		WYOMING			
NOT IN WILDERNESS	(NO NAME)	4D1-029	42-57'42"N	109-21'27"W	2
NOT IN WILDERNESS	(NO NAME)	4D1-030	42-56'51"N	109-19'28"W	2
NOT IN WILDERNESS	(NO NAME)	4D1-031	42-53'38"N	109-15'50"W	2
NOT IN WILDERNESS	(NO NAME)	4D2-009	45-00'03"N	109-31'50"W	2
NOT IN WILDERNESS	(NO NAME)	4D2-024	42-53'37"N	109-14'31"W	2
NOT IN WILDERNESS	(NO NAME)	4D2-030	42-35'24"N	108-53'45"W	2
NOT IN WILDERNESS	(NO NAME)	4D2-056	43-25'13"N	109-49'35"W	4
NOT IN WILDERNESS	(NO NAME)	4D3-012	44-55'00"N	110-42'32"W	1
NOT IN WILDERNESS	(NO NAME)	4D3-015	44-47'54"N	110-45'53"W	1
NOT IN WILDERNESS	(NO NAME)	4D3-018	44-30'30"N	110-22'45"W	1
NOT IN WILDERNESS	(NO NAME)	4D3-019	44-22'25"N	110-27'10"W	4
NOT IN WILDERNESS	(NO NAME)	4D3-020	44-10'37'N	110-17'00"W	4
NOT IN WILDERNESS	(NO NAME)	4D3-025	43-52'30"N	110-43'45"W	4
NOT IN WILDERNESS	(NO NAME)	4D3-028	43-47'41"N	109-32'28"W	2
NOT IN WILDERNESS	(NO NAME)	4D3-032	43-25'15"N	110-01'55"W	4
NOT IN WILDERNESS	(NO NAME)	4D3-037	42-44'47"N	110-45'22"W	4
NOT IN WILDERNESS	(NO NAME)	4D3-048	44-24'50"N	107-22'05"W	2
NOT IN WILDERNESS	(NO NAME)	4D3-070	42-55'18"N	110-21'45"W	4
NOT IN WILDERNESS	(NO NAME)	4D3-073	44-49'45"N	110-50'35"W	1
NOT IN WILDERNESS	(NO NAME)	4D3-075	44-13'05"N	111-01'40"W	4
NOT IN WILDERNESS	(NO NAME)	4E2-001	41-23'27"N	106-21'45"W	2
NOT IN WILDERNESS	(NO NAME)	4E2-002	41-22'24"N	106-19'45"W	2
NOT IN WILDERNESS	(NO NAME)	4E2-005	41-19'50"N	106-20'54"W	2
NOT IN WILDERNESS	(NO NAME)	4E2-061	41-22'17"N	106-19'45"W	2
NOT IN WILDERNESS	(NO NAME)	4E3-001	42-36'40"N	106-04'56"W	2
NOT IN WILDERNESS	(NO NAME)	4E3-002	41-25'29"N	106-19'54"W	2
NOT IN WILDERNESS	(NO NAME)	4E3-003	41-21'04"N	106-15'48"W	2
NOT IN WILDERNESS	BAPTISTE LAKE	4D1-032	42-52'30"N	109-18'25"W	2
NOT IN WILDERNESS	CHAIN LAKES (LARGEST)	4D3-035	42-58'19"N	109-53'36"W	4
NOT IN WILDERNESS	DOLLAR LAKE	4D2-010	44-55'06"N	109-29'25"W	2
NOT IN WILDERNESS	FERN LAKE	4D3-017	44-40'40"N	110-16'30"W	1
NOT IN WILDERNESS	FLAT LAKE	4D2-011	43-26'45"N	109-49'45"W	4
NOT IN WILDERNESS	GEM LAKE	4D2-048	44-24'05"N	107-02'52"W	2
NOT IN WILDERNESS	GOOSE LAKE	4D3-052	44-32'30"N	110-50'30"W	4
NOT IN WILDERNESS	GRASSY LAKE RESERVOIR	4D3-021	44-07'40"N	110-48'30"W	4
NOT IN WILDERNESS	ISLAND LAKE	4D1-063	44-56'50"N	109-32'30"W	2
NOT IN WILDERNESS	KIRKLAND LAKE	4D2-015	43-08'10"N	109-23'45"W	2
NOT IN WILDERNESS	KISINGER LAKES (NW)	4D3-057	43-44'28"N	109-55'53"W	2
NOT IN WILDERNESS	LITTLE BEAR LAKE	4D1-064	44-56'30"N	109-31'30"W	2
NOT IN WILDERNESS	LONG LAKE	4D1-065	44-56'45"N	109-30'07"W	2
NOT IN WILDERNESS	LOOKOUT LAKE	4E2-006	41-20'45"N	106-19'15"W	2
NOT IN WILDERNESS	LOON LAKE	4D3-060	44-06'55"N	110-57'00"W	4
NOT IN WILDERNESS	LOST LAKE	4D3-058	43-00'42"N	110-51'37"W	4
NOT IN WILDERNESS	LOWER SWEENEY LAKE	4D2-016	42-59'32"N	109-41'35"W	4
NOT IN WILDERNESS	MC BRIDE LAKE	4D3-013	44-57'52"N	110-15'00"W	1
NOT IN WILDERNESS	MILKY LAKES (SOUTHWEST)	4D1-027	42-59'00"N	109-27'12"W	2
NOT IN WILDERNESS	MIRROR LAKE	4E2-058	41-20'19"N	106-19'07"W	2
NOT IN WILDERNESS	MOERKE LAKE	4E3-063	41-29'13"N	106-25'22"W	2
NOT IN WILDERNESS	NEW FORK LAKES (SW)	4D3-034	43-05'30"N	109-57'18"W	4
NOT IN WILDERNESS	NYMPH LAKE	4D3-016	44-45'03"N	110-43'36"W	1
NOT IN WILDERNESS	PETES LAKE	4D2-029	42-44'40"N	108-57'30"W	2
NOT IN WILDERNESS	SAWMILL LAKES (NE)	4D3-047	44-37'33"N	107-17'38"W	2
NOT IN WILDERNESS	SHELF LAKES (SW)	4E2-004	41-22'35"N	106-17'33"W	2
NOT IN WILDERNESS	SOUTH GAP LAKE	4E2-003	41-22'10"N	106-17'55"W	2
NOT IN WILDERNESS	TIGEE LAKE	4D1-026	43-00'28"N	109-20'20"W	2
NOT IN WILDERNESS	TRAPPER LAKE	4D3-074	43-49'49"N	110-43'55"W	4
NOT IN WILDERNESS	UPPER NORTH CROW RES.	4E3-004	41-14'12"N	105-17'00"W	2
NOT IN WILDERNESS	WALL LAKE	4D1-054	44-59'05"N	109-33'05"W	1
NOT IN WILDERNESS	WEST TENSLEEP LAKE	4D3-049	44-15'40"N	107-12'54"W	2
NOT IN WILDERNESS	WORTHERN MEADOW RES.	4D3-039	42-42'00"N	108-55'15"W	2

Table A-2. List of lakes in National Parks

NAME OF NATIONAL PARK	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE
CALIFORNIA				
KINGS CANYON	(NO NAME)	4A1-029	37-10'20"N	118-44'40"W
KINGS CANYON	(NO NAME)	4A1-033	37-01'45"N	118-41'45"W
KINGS CANYON	(NO NAME)	4A1-034	37-04'00"N	118-38'20"W
KINGS CANYON	(NO NAME)	4A1-035	37-01'37"N	118-29'30"W
KINGS CANYON	(NO NAME)	4A1-038	36-54'10"N	118-33'30"W
KINGS CANYON	(NO NAME)	4A1-040	36-48'15"N	118-25'10"W
KINGS CANYON	(NO NAME)	4A1-041	36-43'05"N	118-31'50"W
KINGS CANYON	(NO NAME)	4A1-053	36-48'40"N	118-25'49"W
KINGS CANYON	(NO NAME)	4A1-056	37-08'40"N	118-39'50"W
KINGS CANYON	HORSESHOE LAKES (MIDDLE)	4A1-036	36-56'37"N	118-34'15"W
KINGS CANYON	STOCKING LAKE	4A1-039	36-52'15"N	118-22'15"W
KINGS CANYON	SWAMP LAKES (WESTERN)	4A1-037	36-53'20"N	118-43'25"W
LASSEN VOLCANIC	(NO NAME)	4A3-010	40-31'27"N	121-24'48"W
LASSEN VOLCANIC	EMERALD LAKE	4A3-012	40-28'05"N	121-31'04"W
LASSEN VOLCANIC	FEATHER LAKE	4A3-011	40-31'30"N	121-22'45"W
LASSEN VOLCANIC	GLEN LAKE	4A2-003	40-27'12"N	121-15'54"W
LASSEN VOLCANIC	LITTLE BEAR LAKE	4A3-072	40-31'22"N	121-24'21"W
LASSEN VOLCANIC	SHADOW LAKE	4A3-054	40-29'45"N	121-28'05"W
LASSEN VOLCANIC	SWAN LAKE	4A3-013	40-29'52"N	121-21'45"W
SEQUOIA	(NO NAME)	4A1-042	36-40'55"N	118-24'25"W
SEQUOIA	(NO NAME)	4A1-043	36-36'25"N	118-38'45"W
SEQUOIA	(NO NAME)	4A1-044	36-39'40"N	118-26'00"W
SEQUOIA	(NO NAME)	4A1-045	36-37'20"N	118-20'45"W
SEQUOIA	(NO NAME)	4A1-046	36-34'37"N	118-32'04"W
SEQUOIA	(NO NAME)	4A1-047	36-31'37"N	118-18'20"W
SEQUOIA	BIG FIVE LAKES (SMALL N)	4A1-048	36-29'04"N	118-31'10"W
SEQUOIA	HOCKETT LAKES (CENTER)	4A2-045	36-21'29"N	118-39'58"W
SEQUOIA	WRIGHT LAKES(NW)	4A1-060	36-38'11"N	118-22'00"W
YOSEMITE	(NO NAME)	4A1-006	38-05'12"N	119-42'19"W
YOSEMITE	(NO NAME)	4A1-008	38-04'15"N	119-46'53"W
YOSEMITE	(NO NAME)	4A1-010	38-03'30"N	119-39'09"W
YOSEMITE	(NO NAME)	4A1-016	37-42'15"N	119-17'15"W
YOSEMITE	(NO NAME)	4A1-055	38-05'10"N	119-40'24"W
YOSEMITE	(NO NAME)	4A2-036	37-57'10"N	119-50'17"W
YOSEMITE	BINGAMAN LAKE	4A1-015	37-50'45"N	119-14'45"W
YOSEMITE	LAKE VERNON	4A1-009	38-00'50"N	119-43'22"W
YOSEMITE	MARY LAKE	4A1-007	38-08'39"N	119-33'40"W
YOSEMITE	VOGELSANG LAKE	4A1-059	37-47'12"N	119-20'35"W
COLORADO				
ROCKY MOUNTAIN	(NO NAME)	4E1-011	40-29'15"N	105-38'40"W
ROCKY MOUNTAIN	(NO NAME)	4E1-016	40-21'29"N	105-45'05"W
ROCKY MOUNTAIN	(NO NAME)	4E1-017	40-20'35"N	105-43'55"W
ROCKY MOUNTAIN	(NO NAME)	4E1-019	40-18'47"N	105-43'45"W
ROCKY MOUNTAIN	(NO NAME)	4E1-035	40-10'04"N	105-41'54"W
ROCKY MOUNTAIN	ARROWHEAD LAKE	4E1-014	40-23'00"N	105-45'40"W
ROCKY MOUNTAIN	AZURE LAKE	4E1-015	40-22'18"N	105-46'15"W
ROCKY MOUNTAIN	BLACK LAKE	4E1-025	40-15'55"N	105-38'27"W
ROCKY MOUNTAIN	BLUEBIRD LAKE	4E1-051	40-11'30"N	105-39'15"W
ROCKY MOUNTAIN	BOX LAKE	4E1-030	40-12'47"N	105-38'53"W
ROCKY MOUNTAIN	CHIQUITA LAKE	4E1-013	40-26'28"N	105-40'42"W
ROCKY MOUNTAIN	FIFTH LAKE	4E1-029	40-12'47"N	105-40'44"W
ROCKY MOUNTAIN	FINCH LAKE	4E1-038	40-11'00"N	105-35'33"W
ROCKY MOUNTAIN	FOURTH LAKE	4E1-054	40-13'18"N	105-41'07"W
ROCKY MOUNTAIN	GLASS LAKE	4E1-023	40-16'52"N	105-39'55"W
ROCKY MOUNTAIN	HAYNACH LAKES (NW)	4E1-018	40-20'47"N	105-45'55"W

Table A-2. List of lakes in National Parks

NAME OF NATIONAL PARK	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE
COLORADO				
ROCKY MOUNTAIN	HUTCHESON LAKES(NORTHERN)	4E1-037	40-10'26"N	105-38'50"W
ROCKY MOUNTAIN	JEWEL LAKE	4E1-024	40-17'12"N	105-38'23"W
ROCKY MOUNTAIN	JUNCO LAKE	4E1-034	40-11'01"N	105-39'45"W
ROCKY MOUNTAIN	KEPLINGER LAKE	4E1-032	40-14'33"N	105-37'28"W
ROCKY MOUNTAIN	LAKE HAIYAHA	4E1-022	40-18'17"N	105-39'45"W
ROCKY MOUNTAIN	LAKE HUSTED	4E1-010	40-30'35"N	105-36'36"W
ROCKY MOUNTAIN	LAKE NANITA	4E1-027	40-15'23"N	105-43'00"W
ROCKY MOUNTAIN	LAKE POWELL	4E1-026	40-15'17"N	105-39'35"W
ROCKY MOUNTAIN	LAKE VERNA	4E1-028	40-13'35"N	105-42'28"W
ROCKY MOUNTAIN	LOOMIS LAKE	4E1-020	40-20'16"N	105-41'45"W
ROCKY MOUNTAIN	MILLS LAKE	4E1-060	40-17'20"N	105-38'25"W
ROCKY MOUNTAIN	MIRROR LAKE	4E1-053	40-32'15"N	105-41'52"W
ROCKY MOUNTAIN	SANDBEACH LAKE	4E1-033	40-13'08"N	105-36'05"W
ROCKY MOUNTAIN	SHEEP LAKES (LG.NW)	4E3-055	40-24'17"N	105-37'15"W
ROCKY MOUNTAIN	SNOWBANK LAKE	4E1-031	40-14'25"N	105-38'40"W
ROCKY MOUNTAIN	SNOWDRIFT LAKE	4E1-058	40-18'25"N	105-44'04"W
ROCKY MOUNTAIN	SPECTACLE LAKES (NW)	4E1-012	40-27'04"N	105-40'30"W
ROCKY MOUNTAIN	TIMBER LAKE	4E1-057	40-22'27"N	105-47'45"W
ROCKY MOUNTAIN	TWO RIVERS LAKE	4E1-021	40-19'17"N	105-40'55"W
MONTANA				
GLACIER	(NO NAME)	4C3-002	48-56'34"N	113-43'00"W
GLACIER	(NO NAME)	4C3-004	48-49'10"N	113-56'22"W
GLACIER	COBALT LAKE	4C3-013	48-26'04"N	113-25'30"W
GLACIER	FEATHER WOMAN LAKE	4C3-010	48-37'04"N	113-46'38"W
GLACIER	GLENNS LAKE	4C3-062	48-54'10"N	113-47'30"W
GLACIER	HARRISON LAKE	4C3-011	48-31'10"N	113-46'00"W
WASHINGTON				
MOUNT RAINIER	CHENUIS LAKES (SOUTHERN)	4B1-018	46-58'17"N	121-46'42"W
MOUNT RAINIER	GOLDEN LAKES (LARGEST)	4B1-017	46-53'20"N	121-53'55"W
MOUNT RAINIER	GOLDEN LAKES (SW)	4B1-069	46-53'08"N	121-54'23"W
MOUNT RAINIER	LAKE ALLEN	4B3-057	46-45'54"N	121-53'30"W
NORTH CASCADES	BERDEEN LAKE	4B1-048	48-43'00"N	121-27'45"W
NORTH CASCADES	DOUBTFUL LAKE	4B1-046	48-28'27"N	121-02'47"W
NORTH CASCADES	HIDDEN LAKE	4B2-070	48-29'45"N	121-11'15"W
NORTH CASCADES	SILVER LAKE	4B1-050	48-59'15"N	121-13'45"W
NORTH CASCADES	TAPTO LAKES (EAST)	4B1-051	48-53'05"N	121-22'05"W
OLYMPIC	(NO NAME)	4B3-032	47-50'23"N	123-11'18"W
OLYMPIC	(NO NAME)	4B3-056	47-39'33"N	123-29'20"W
OLYMPIC	BOULDER LAKE	4B3-063	47-58'35"N	123-44'53"W
OLYMPIC	HOH LAKE	4B3-035	47-53'57"N	123-47'05"W
OLYMPIC	LUNCH LAKE	4B3-061	47-54'57"N	123-46'55"W
WYOMING				
GRAND TETON	(NO NAME)	4D3-025	43-52'30"N	110-43'45"W
GRAND TETON	GRASSY LAKE RESERVOIR	4D3-021	44-07'40"N	110-48'30"W
GRAND TETON	TRAPPER LAKE	4D3-074	43-49'49"N	110-43'55"W
YELLOWSTONE	(NO NAME)	4D1-006	44-38'25"N	110-22'40"W
YELLOWSTONE	(NO NAME)	4D3-012	44-55'00"N	110-42'32"W
YELLOWSTONE	(NO NAME)	4D3-015	44-47'54"N	110-45'53"W
YELLOWSTONE	(NO NAME)	4D3-018	44-30'30"N	110-22'45"W

Table A-2. List of lakes in National Parks

NAME OF NATIONAL PARK	LAKE NAME	LAKE IDENTIFICATION NO.	LATITUDE	LONGITUDE
		WYOMING		
YELLOWSTONE	(NO NAME)	403-019	44-22'25"N	110-27'10"W
YELLOWSTONE	(NO NAME)	403-020	44-10'37'N	110-17'00"W
YELLOWSTONE	(NO NAME)	403-073	44-49'45"N	110-50'35"W
YELLOWSTONE	(NO NAME)	403-075	44-13'05"N	111-01'40"W
YELLOWSTONE	FERN LAKE	403-017	44-40'40"N	110-16'30"W
YELLOWSTONE	GOOSE LAKE	403-052	44-32'30"N	110-50'30"W
YELLOWSTONE	MC BRIDE LAKE	403-013	44-57'52"N	110-15'00"W
YELLOWSTONE	NYMPH LAKE	403-016	44-45'03"N	110-43'36"W

APPENDIX B

CORRESPONDENCE WITH THE U.S. FISH AND WILDLIFE SERVICE

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Endangered Species, Field Office
Federal Bldg., U.S. Courthouse
301 South Park
P.O. Box 10023
Helena, Montana 59626

IN REPLY REFER TO:
W.11(I)
M.11(I)

January 2, 1985

[illegible]
[illegible]
ENVIRONMENTAL EVALUATION
BRANCH

Mr. Ronald A. Lee
Acting Chief, Environmental Branch
U.S. Environmental Protection Agency
1200 Sixth Avenue
Seattle, Washington 98101

Dear Mr. Lee:

Thank you for contacting us regarding the western lakes portion of the national acid rain surface water survey. The Federally listed as endangered or threatened species that may occur, either seasonally or as residents, in the project area in Montana and Wyoming include; the bald eagle, peregrine falcon, whooping crane, gray wolf and grizzly bear.

To minimize any potential impacts to listed speices, we encourage scheduling helicopter flights that minimize noise impacts by flying to and fromthe sample sites as high as possible; and preferrably above 1200 feet above ground. In addition, as a precautionary measure, we would recommend that the time spent operating helicopters at low altitudes above the sample site be held to a minimum. Overall, we have no substantive concerns that the proposed project will impact listed endangered or threatened species that may occur in the sampling areas in Montana and Wyoming.

We have contacted our Ecological Services Division in Billings, Montana. Mr. Bill Jones of that office will be contacting you soon. His FTS number is 585-6750. He is the FWS Environmental Contaminat Coordinator for Montana and Wyoming.

Please keep us on your mailing list so we can track this project. Again, thank you for your efforts to conserve listed species.

Sincerely,

Wayne G. Brewster

Wayne G. Brewster
Field Supervisor
Endangered Species

United States Department of the Interior

FISH AND WILDLIFE SERVICE
2800 Cottage Way, Room E-1823
Sacramento, California 95825

RECEIVED
JAN 11 1985
ENVIRONMENTAL EVALUATION BRANCH

3 January 1985

Mr. Ronald A. Lee, Acting Chief
Environmental Evaluation Branch
U.S. Environmental Protection Agency
1200 Sixth Avenue
Seattle, Washington 98101

In reply refer to:
1-1-85-SP-123

Subject: Environmental Assessment for California Lakes Portion of the National Acid Rain Surface Water Survey

Dear Mr. Lee:

This letter responds to your recent request for information regarding possible impacts to endangered and threatened species from the proposed activity. To the best of our knowledge, and with the information provided in your letter (M/S 443), we anticipate no impact to any listed or proposed species in California.

The endangered bald eagle (Haliaeetus leucocephalus) occurs at or near many of the lakes listed in your report. Nesting occurs at some localities (e.g., Snag Lake and Lake Almanor). However, because your sampling is proposed in the autumn, after the nesting season, we believe no impacts will result.

If we may be of further assistance, please contact Dr. Jack Williams of my staff at the above address or at 916/484-4935. Thank you for your concern.

Sincerely,

Jack E. Williams
For Gail C. Kobetich
Project Leader

cc: Regional Director, Portland, OR (AFA-SE)
Field Supervisor, Sacramento, CA (ES-S)
Field Supervisor, Laguna Niguel, CA (ES-LN)

United States Department of the Interior
U. S. FISH AND WILDLIFE SERVICE
ENDANGERED SPECIES OFFICE
2078 Administration Building
1745 West 1700 South
Salt Lake City, Utah 84104

IN REPLY REFER TO:

January 8, 1985

RECEIVED
JAN 11 1985
ENVIRONMENTAL EVALUATION BRANCH

Ronald A. Lee
Environmental Evaluation Branch
Environmental Protection Agency
1200 Sixth Avenue
Seattle, Washington 98101

Dear Mr. Lee:

We have reviewed your undated letter which was received in this office on December 17, 1984 concerning the proposal by your agency to conduct a national acid rain surface water survey.

It appears that listed endangered and threatened species, or species proposed for listing, may occur in the area of influence of this action. Therefore, we are furnishing you the following list of species and critical habitat which may be present in the concerned area:

Listed

Peregrine falcon	Falco peregrinus
Bald eagle	Haliaeetus leucocephalus

The Federal agency should review their proposed action and determine if the action would affect any listed species or their critical habitat. You should also determine if the action is likely to jeopardize the continued existence of proposed species or result in the destruction or an adverse modification of any critical habitat proposed for such species. If the determination is "may affect" for listed species you must request in writing formal consultation from the Field Supervisor, U.S. Fish and Wildlife Service (FWS) at the address given above. In addition, if you determine that the proposed action is likely to jeopardize the continued existence of proposed species or result in the destruction or adverse modification of proposed critical habitat, you must confer with the FWS. At this time you should provide this office a copy of the biological assessment and any other relevant information that assisted you in reaching your conclusion.

Specific concerns the FWS has about this project and its potential impacts on T&E species are as follows:

1. Both of the above species may occur in one or more of the lake areas to be surveyed. Our only concerns would be if the timetable for the sampling would be changed to occur during the spring nesting period. This would be from March 1 to June 30. If this does not occur and all of the work is done in the fall, no listed species should be impacted.

The FWS can enter into formal Section 7 consultation only with another Federal agency or its designee. State, county, or any other governmental or private organizations can participate in the consultation process, help prepare information such as the biological assessment, participate in meetings, etc.

Your attention is also directed to Section 7(d) of the Endangered Species Act, as amended, which underscores the requirement that the Federal agency or the applicant shall not make any irreversible or irretrievable commitment of resources during the consultation period which, in effect, would deny the formulation or implementation of reasonable and prudent alternatives regarding their actions on any endangered or threatened species.

We are prepared to assist you whenever you have questions which we may be able to answer. If we can be of further assistance, please advise us.

The FWS representative who will provide you technical assistance is Robert Benton, FTS: 588-4430.

Sincerely,

Robert G. Ruesink

Robert G. Ruesink
Acting Field Supervisor

March 3, 1849

United States Department of the Interior

FISH AND WILDLIFE SERVICE
ENDANGERED SPECIES PROGRAM
4620 Overland Road, Room 209
Boise, Idaho 83705

January 10, 1985

RECEIVED
JAN 21 1985
ENVIRONMENTAL EVALUATION
BRANCH

Ronald A. Lee
Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, Washington 98101

Re: National Acid Rain Survey
ER #84/1600, FWS-1-4-85-SP-80
(1019.0100)

Dear Mr. Lee:

This responds to your letter of December 17, 1984, proposing the Environmental Assessment for the western lakes portion of the national acid rain surface water survey. We have reviewed it for impacts to migratory birds, anadromous fish, and federally-listed threatened and endangered species. Our comments are provided on a technical assistance basis.

The impacts on migratory birds and anadromous fish would be insignificant. Attachment A lists endangered, threatened and candidate species that may be present in your project areas.

Candidate species are included for your information. These species are presently being reviewed by this Service for consideration of listing as threatened or endangered. It should be noted that candidate species have no protection under the Endangered Species Act of 1973 (ESA), as amended, but are included for your early planning consideration. Candidate species could be formally proposed and listed in the future, thereby, falling within the scope of Section 7 of the Endangered Species Act. We suggest you consider informal consultation with this office if the project is likely to impact a candidate species.

You should conduct a biological assessment to determine if listed species are likely to be affected (adversely or beneficially) by your project. If a listed species will be affected, your agency should request formal Section 7 consultation from my office. If you have additional questions regarding your responsibilities under the ESA, please contact Mr. Jay Gore at FTS: 554-1806.

Sincerely yours,

John P. Wolflin
Field Supervisor

Attachment

cc: FWS, Portland (AFA-SE)
FWS, Boise (ES)
FWS, EC, Washington, D.C.
IDFG, Hdqtrs., Boise

Attachment A

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES, AND CANDIDATE SPECIES, THAT MAY OCCUR WITHIN THE EA SURVEY AREA FOR ACID RAIN IN ASSORTED COUNTIES, IDAHO

1-4-85-SP-80

LISTED SPECIES

Gray Wolf (*Canis lupus*) - Lakes in central Idaho.
Grizzly Bear (*Ursus arctos*) - Lakes in Bonner and Boundary Counties, Idaho.
Woodland Caribou (*Rangifer tarandus*) - Lakes in Bonner and Boundary Counties, Idaho.

PROPOSED SPECIES

None

CANDIDATE SPECIES - Plant

Aster jessicae (Roman Nose Lakes, T61N, R2W, Sec. 16)

APPENDIX C

NOISE

The following tables (Tables C-1, C-2, and C-3) are from FAA sources on performance of the Bell 206L (Long Ranger) helicopter (Newman et al. 1982). From these tables one can estimate the sound intensities likely to accrue in the vacinity of the helicopter activity in the wilderness. No attempt has been made to assess the degree of attenuation that would occur due to vegetation and terrain, nor reflections from rock cliffs, etc. Helicopters would not be expected to climb or approach lakes at the angles and speeds used in these tables because of the terrain. While intensities would thus be higher, the duration would decrease with a faster ascent or descent. Level flyovers in Table C-2 are at altitudes of 500 ft, while it would be recommended that helicopters fly at a 2,000 ft elevation above terrain for the purposes of the lake study. Noise curve data are not available for level flyovers of 2,000 ft.

Table C-1. Bell 206L Takeoff/Approach Data Table (Source: Newman et al. 1982)

CPA[a] Distance (FT)	Takeoff SEL[b] (dB)	Approach SEL (dB)
200	89.2	89.3
400	84.9	85.2
600	82.3	82.7
1000	78.7	79.4
2000	73.4	74.7
4000	67.9	69.4
6000	63.9	65.7
10000	58.3	60.4

Takeoff Notes

Vy (Speed for best rate of climb) - 52 kts

BRC (Best rate of climb) - 1380 feet per minute (fpm)

Climb Angle (degrees) - 15.2°

Climb Gradient (Run/Rise) - 3.7

Takeoff Weight = 4,000 lbs

Approach Notes

Vy (Speed for best rate of climb) = 52 kts

Approach Angle (degrees) = 6°

---

[a] Closest point of approach.

[b] Sound exposure level expressed in decibels. The integration of dB_A time history, normalized to 1 sec. SEL numbers would be higher than the corresponding dB_A numbers depending on the context.

Table C-2. Bell 206L Level Flyover Data Table (Source: Newman et al. 1982)

CPA[a] Distance (FT)	V[b]=60 kts SEL[c] (dB)	V=80 kts SEL (dB)	V-100 kts SEL (dB)	V=114.3 kts SEL (dB)	V=120 kts SEL (dB)	V=130 kts SEL (dB)
200	90.5	88.4	87.3	87	87.2	88.5
400	86.2	84.1	83.0	82.7	82.9	84.2
600	83.6	81.5	80.4	80.1	80.3	81.6
1000	80.1	78.0	76.9	76.6	76.8	78.1
2000	74.9	72.8	71.7	71.4	71.6	72.9
4000	69.6	67.5	66.4	66.1	66.3	67.6
6000	65.6	63.5	62.4	62.1	62.3	63.6
10000	59.9	57.8	56.7	56.4	56.6	57.9

[a] Closest point of approach.

[b] Velocity in level flight.

[c] Sound exposure level expressed in decibels.

Table C-3. Bell 206L Hover Data Table[a] (Source: Newman et al. 1982)

CPA[b] Distance (FT)	A Ground-to-Ground	B Low Angle OGE[c] Hover	C Air-to-Ground OGE Hover Direct Climb
200	85.0	88.0	90
400	78.2	81.2	83.7
600	73.5	76.5	80.8
1000	66.1	69.1	75.1
2000	56.5	59.4	68.0
4000	47.4	50.4	60.2
6000	42.1	45.1	55.1
10000	35	38.0	48.0
Application	Stationary Hover Hover Taxi	Stationary Hover Hover Taxi	Direct Climb

[a] Detailed understanding of the derivation of these figures requires consulting Newman et al. 1982.

[b] Closest point of approach.

[c] Out-of-ground effect.

APPENDIX D

SAFETY

The NTSB has analyzed data for rotorcraft accidents for the years 1977 through 1979, during which time a total of 890 helicopter accidents occurred, including 125 fatal accidents in which 205 persons died. [These data are compiled in NTSB 1981a, and supported by data listed in NTSB 1981b and also by data gathered for 1980 (NTSB 1984a)]. These data form the basis for the discussion which follows.

Accident Types

Forty percent of the accidents in which the rotorcraft were destroyed had accompanying fatalities. Fire after impact occurred in only 9% of the accidents and 32 involved fatalities. In many high-altitude areas, forest fire possibility is remote (low oxygen and organic fuel sources). More than 40% of the rotorcraft accidents with fires after impact were fatal, while only 11% with no fire after impact were fatal. During the study period, the most frequent accident type was engine failure or malfunction (256), which included accidents that occurred after a power loss for any reason. The power losses were most often the result of powerplant mechanical problems (181) or fuel exhaustion (45), fuel starvation (17), or fuel contamination (8). These failures/ malfunctions occurred most frequently during flight (186) vs on takeoff (44) or landing (25). The next most frequent accident types were collisions with obstacles and controlled or uncontrolled collisions with the ground or water. Fatalities most frequently occurred in collisions between aircraft in flight (66.7% fatal), airframe failures in flight and propeller failures (50% fatal), uncontrolled collisions with the ground or water (37.8% fatal), and main rotor failure (26.3% fatal). These fatalities did not occur chiefly during take-offs or landings: accidents which occurred during the in-flight phase of operation (i.e., cruising or overflight) were the ones which most frequently resulted in fatalities (26%). Only 10.5% of the accidents which occurred in the landing phase of the operation were fatal.

The NTSB and the FAA both collect data on aircraft accidents. The closest category to the type of flying demanded for the proposed survey is the NTSB category "aerial observation," which includes the NTSB categories of aerial survey, aerial mapping, hunting, fish spotting, power and pipeline patrol, police patrol, search and rescue, and highway traffic advisory. Such a categorization is the most compatible with the FAA category of "other." The FAA is the only known collector of data on the types of aircraft use by which they stratify flight exposure data (flying hours). Using this categorization, helicopters involved in aerial observation activities represented about 25% of the total helicopter hours flown and had an accident rate of 12.09/100,000 h flown. For the 1977-1979 study period, aerial observation category accidents totaled 58, of which 16 (27.6%) involved fatal injuries, 6 serious injuries, 12 minor injuries, and 24 no injuries. This reported fatality rate was the highest of all categories of flying. Twenty one of the 58 accidents involved engine failure/malfunction.

Accident Causal Factors

Pilot. The pilot was the major cause or a related factor in the accidents in the 1977-1979 study. More than 64% of the accidents in which the NTSB cited a probable cause fell into this category. The pilot was cited as a cause or related factor in 60% of the fatal accidents in which a probable cause was determined. As many as two-thirds of the pilots involved in rotorcraft accidents were flying in a professional capacity. Eighty-three percent of the pilots in the aerial observation category accidents had commercial licenses. Ninety-three percent of the helicopter pilots in this flying category who were involved in accidents had at least 1000 h of flying time and 55.2% had over 3000 h of flying time. Thus, the accidents do not generally involve inexperienced pilots. Sixty-seven percent of the aerial observation category pilots involved in accidents had over 250 h in the type of aircraft being flown, and 32.7% had over 500 h flying time in the accident rotorcraft. Forty-five of these same pilots had at least 100 h flying time in the accident rotorcraft type within the last 90 d of the accident. Twenty-nine percent had under 50 h. Data analyzed for factors such as pilot fatigue or overwork show only 7.4% of these same pilots had flown 9 or more hours in the 24 h prior to the accident.

Environment. Considering all categories of rotorcraft flying during the study period, there were no fatal accidents in which weather, terrain, or airport facilities were the chief causal factors. Terrain was cited in 31 nonfatal accidents and weather was cited in 6 nonfatal accidents. Weather and terrain were, however, at least contributing factors in numerous accidents (Table D-1). Although a significant number of rotorcraft accidents were at least partially caused by unfavorable wind conditions, updrafts and downdrafts, and high-density altitude, most were not fatal. Low ceiling, fog, rain, and similar conditions which affected pilot visibility were the most common factors contributing to fatal accidents. Thirty-eight percent of the accidents which occurred under instrument flying conditions were fatal, while only 13% of the accidents occurring under noninstrument conditions were fatal.

Helicopter Type

The accident rates of different helicopter makes and models are affected by factors such as the number of hours flown, design concepts, the kind of use of the rotorcraft, and the manufacturing techniques. The quality of the maintenance can be another factor. The EPA has not yet decided which helicopter types to use in the proposed action. A combination of piston and turbine models will undoubtedly be used, with turbine models predominating. Bell long rangers, Bell jet rangers, Hueys and Lamas are the rotor craft of choice. Based on the 1977-1979 data, accident rates might be as much as twice as high with specific turbine models as the mean for all turbine models needed at higher altitudes, although accident rates (but not fatal accidents) for turbine models are generally significantly lower than for piston models (Table D-2). Using data collected from 1975-1981, the NTSB has projected that turbine engine helicopters could be expected to have an accident every 11,961.4 flying hours, a fatality every 37,863.3 flying hours, and an accident with one or more fatalities every 72,095.0 flying hours (NTSB, 1984b).

Because the data in Table D-2 may be affected by particularly hazardous or accident-prone uses, such as aerial spraying and personal/business flying, the data can be most meaningfully interpreted by considering only the aerial observation category (roughly termed "other" in FAA exposure data). Piston-powered rotorcraft accounted for 130 accidents in 860,771 h for a rate of 15.1 accidents per 100,000 flying hours. Turbine-powered rotorcraft accounted for 74 accidents in 819,738 h for a rate of 9.0 accidents per 100,000 flying hours. Pilots involved in turbine-powered rotorcraft accidents are more experienced, in terms of flight

Table D-1. Weather or terrain factors as contributing causes in rotorcraft accidents, 1977-1979

	Fatal Accidents	Total Accidents
Weather causes/factors		
Unfavorable wind conditions	4	40
High-density altitude	1	26
Fog	9	17
Low ceiling	8	18
Downdrafts and updrafts	1	10
Rain	6	7
Snow	2	7
Icing conditions, conditions conducive to carburetor icing	2	7
Other	7	23
Total weather cause/factor	40	155
Terrain causes/factors		
High obstructions	13	102
Rough, uneven ground	2	40
Wet, soft ground	0	27
High vegetation	0	21
Other	3	30
Total terrain cause/factor	18	220

Source: NTSB 1981a.

Table D-2. Accident rates for piston- and turbine-powered rotorcraft, 1977-1979

	Piston-powered rotorcraft	Turbine-powered rotorcraft
Hours flown	2,306,550	4,343,932
Total accident records	626	265
Mean total rate per 100,000 h	27.14	6.10
Fatal accident records	72	53
Mean fatal rate per 100,000 h	3.12	1.22

Source: NTSB 1981a.

Table D-3. Number of accidents by type of power in relation to in-flight phase of operation

In-flight phase of operation	Piston	Turbine	Total
Climb to cruise	10	4	14
Normal cruise	102	73	175
Descending	5	4	9
Hovering	28	29	57
Power-on descent	6	1	7
Autorotative descent	5	5	10
Uncontrolled descent	7	7	14
Low pass	11	5	16
Other	23	7	30
Total accident records	197	135	332

Source: NTSB, 1981a.

time, than are the pilots involved in piston-powered rotorcraft accidents. By the category of aerial observation, piston-powered rotorcraft accidents had 26.2% of their accidents involving fatalities, while 31.3% of the turbine-powered rotorcraft involved fatalities. The NTSB hypothesizes that the greater flying speeds and higher altitudes resulting in greater impact speeds in turbine-powered rotorcraft accidents account for, in part, the larger percentage of turbine-powered rotorcraft accidents that are fatal. Table D-3 summarizes the relationship between the type of power used and the phase of in-flight operation at the time of the accident.

Table D-4 presents a summary of the helicopter use during the Fall 1984 lake sampling in the Eastern states. As can be seen, the project scheduled ample down time for the helicopters due to accommodate poor weather and mechanical repairs and maintenance. By allowing a flexible schedule, pilots have complete freedom to use their professional judgment about flying conditions.

Table D-4. Summary of Helicopter Activity, National Surface Water Survey, Fall 1984

Site	Lakes Visited	Dates on Site	Days Active	Helicopter Flight Hours	Helicopter Running Hours	% Down Time
Duluth, MN	361	10/7/84-11/8/84	22	156.0	98.0	21.0
Rhinelander, WI	399	10/7/84-10/13/84	27	119.3	95.3	18.0
Bangor, ME	178	10/15/84-10/25/84	10	60.4	48.6	0.0
Lexington, MA	355	10/16/84-11/18/84	21	113.4	82.0	38.2
Lake Placid, NY	268	10/8/84-11/9/84	18	89.0	64.7	36.0
Mt. Pocono, PA	182	10/31/84-11/16/84	10	41.1	27.7	41.2
Asheville, NC	117	11/17/84-11/29/84	7	61.1	37.1	36.0
Lakeland, FL	175	12/2/84-12/14/84	10	41.4	25.3	16.7
Total	2035		125	681.7	479.6	MEAN 25.9

*These data are preliminary and subject to revision.